Spontaneous Combustion in Collieries.[1*]

BY —. DURAND.

Translated and abstracted by Alfred Bache, B. A., Assoc. Inst. C. E.

Causes.—The primary causes of fires breaking out in collieries where the coal is contaminated with pyrites are believed by the author, who is engineer of the Doyet Collieries[2] in the department of Allier, France, to be the three following:—oxidation of pyrites, friction from slippings, and warmth of air-current. Experiments made by Mr. Fayol, have shown that above ground a heap of Commentary small coal, presenting to the air a surface of not more than about 1¼ square yard per cubic yard, will, if once it gets heated to a temperature that lies somewhere between 140° and 212° Fahrenheit, go on heating more and more till at length it takes fire.

Pyrites met with in coal-seams is either amorphous or crystalline, and occurs in the shape of nodules, flakes, bunches, or veins, while sometimes it is so finely disseminated throughout the coal as to be invisible. In dry air and at low temperature it does not oxidise; but its dissemination through coal or shale gives it a more porous character than appertains to it by itself, and in almost all cases it oxidises in moist air and becomes converted into sulphate of iron, the excess of sulphur being set free. The heat developed by the oxidation is further augmented, where there is sufficient moisture present, by the subsequent conversion of the sulphate of iron into hyposulphate, with liberation of sulphuric acid, which, when mixed with one quarter its weight of water, rises to the temperature of 220° Fahrenheit. Various other chemical actions also conduce to the development of heat; while there is no absorption of heat by the formation of any gas during the oxidation of the pyrites. At Doyet Collieries the roof over the thick seam of coal is composed, in some places, of fine shaly sandstone containing pyrites; and near the outcrop, where cracks have occurred in the roof, the moisture from the surface and the air from the mine, penetrating into them, have caused the roof to get red-hot, and to set fire to the timber props. A mere bunch of pyrites, however small, occurring either in the coal itself or in a shale parting, is quite sufficient to serve as a lucifer-match for starting a conflagration. The sulphur liberated by decomposition of pyrites, burns at 480° Fahrenheit, and any sulpho-carbons which may also be formed burn at about 660° Fahrenheit whilst the hydro-carbons of coal will not burn below 930° Fahrenheit at least. Hence pyrites, as furnishing the most inflammable products, is really what gives the start to a fire.

Where pillars of coal become cracked and crushed under the pressure of the roof, slippings occur, producing considerable friction, which develops corresponding heat; and as the surfaces sliding past each other are uneven, the friction and heat are concentrated upon the prominences in contact. The heat thus becomes sufficient not merely to accelerate the action of pyrites, but possibly to ignite coal seemingly free from pyrites, even anthracite hard to burn. In the open working at the outcrop at Doyet, the coal has been set on fire by a sudden slip of the ground above.

An air-current that was warmed by uncondensed steam discharged from an underground engine at Doyet caused a little small coal, which had accumulated against some timbering, to get so hot that the timber took fire after the engine had been at work rather more than three months. In return air-drifts the crushed coal in the roof is particularly liable to heat under the influence of the warm and moist current.

In seams free from pyrites, the author believes oxidation of the hydro-cabons on exposure to air cannot develop heat enough to ignite the coal; and the only way in which he can account for spontaneous combustion in such coal is by the presence of dust or fine slack in the midst of any heaps that are found to be heating. Dust and fine slack he considers capable of exerting a condensing power upon the combustible gases that are ready to escape from bituminous or gaseous coal, and also upon the oxygen of the air; and the heat so developed may become sufficient to fire the gas, and thereby the coal.

While, therefore, spontaneous combustion may occur in any colliery, whether the coal contains pyrites or not, it is more particularly in seams of caking coal, containing pyrites, that, as the workings progress, the pillars left standing grow hot rapidly, under the combined action of oxidation of pyrites, pressure and subsidence of roof, and oxidation of hydro-carbons through condensing power of dust. It is the pyrites however, which, wherever present in any appreciable quantity, plays the principal part in starting ignition, and thus constitutes the primary cause of fire; the other causes are then but secondary, although they may so far supplant the start thus given as to make a seam containing but little pyrites appear readier to fire than one containing much more.

Development.—The development of spontaneous combustion is considered by the author firstly in the case of masses of coal, such as pillars left in working. Really solid pillars never fire; those that do are always fissured with numerous cracks, and are more or less crushed. Outbreaks of fire are encouraged by the presence of any coal crushed small, which in its finely subdivided state promotes the chemical actions that induce heating. Fire first smoulders at the bottom of the innumerable cracks by which the pillars have become fissured under the crushing load they have to support; then the walls of the cracks get red-hot and burn, sometimes bursting suddenly into flame where the previous heating has covered them with bituminous matter. The tarry smell thus occasioned often betrays the existence of fire before it has become visible; and so difficult is it to find its actual seat, that often it is not discovered until it has crept outwards towards the air-current at the mouth of the chinks, and has ignited the crushed coal behind the timbering of the roads, and then the timbering itself. The danger is augmented wherever there are timbered excavations overhead; and still more wherever a timbered drift has been pushed forwards under a mass of crushed coal overhead. Through such a mass air circulates easily, heat and moisture collect there, and fire breaks out quicker than where the overhead coal has been got out previously.

Wherever crushed coal can be harbored on or amongst the rubbish that is packed into the goaf, fire is sure sooner or later to break out. It begins at some distance in from the roads, and creeps out gradually towards them, igniting on the way any timber that may have been left buried in the gob-packing; the pungent wood-smoke gives immediate warning of the fire.

Pillars purposely left unworked, either for maintaining a shaft or because the coal in them is not good enough, are also liable to take fire. The load bears unevenly around them, they crush and crack under it, and small crushed coal accumulates next to the gob-packing; the heavier the pressure, the sooner do the pillars heat and fire. Similar circumstances occur where a nip in the seam stops the getting of coal.

Where the goaf is not packed with rubbish, but the ground is left to fall in, there is certain to be fire if any crushed coal is left behind. The danger is liable to be enhanced by accumulation of explosive gas in the large cavities; as is the case also wherever cavities result from settlement of rubbish packed in the goaf.

As to collieries being set on fire from a lamp or an explosion of fire-damp, the author considers this can only occur where the mass so ignited has got very hot beforehand, and is ready to catch fire in a moment. An explosion moreover throws down a lot of coal that will easily take fire, besides shaking and splitting the pillars, and so rendering them more ready to ignite.

Hard seams of caking coal, containing much gas and pyrites, are the most liable to spontaneous combustion. In very fiery seams the author has noticed that heating occurs generally in the dampest places, or along return air-ways when the air is warm and moist. Where a pillar of bad coal had stood without heating for seven years at the foot of an incline in a current of fresh air from the downcast shaft, an alteration in the ventilation exposed it to the return current of warm moist air, and it then got so hot in two months as to necessitate its speedy removal; by the time it could be worked, it was already too hot to touch in some places.

The nature of the roof tells variably. In some collieries fire is found to break out more readily under a roof of tender shale than under one of thick hard sandstone. At Doyet on the contrary, the thick sandstone roof, settling unevenly after the workings, leaves roof cavities, in which air circulates and encourages heating; while in places where a ceiling of shale separates the coal from the thick sandstone, the shale falls, and no dangerous cavities are left.

Coal or rubbish tipped in heaps above-ground from the pitmouth is liable to heat and fire by oxidation under the action of the air and wet, wherever the smaller stuff that collects at the top of the heap is combustible enough. The fire breaks out a little below the top, on the side most exposed to the wind; and spreads thence throughout the entire tip. It is sometimes started direct from the braziers burning at the pit-mouth to light the landing of the cages; the tip then ignites first at the top, whence the fire spreads downwards and laterally.

Prevention.—If the coal in a seam could only be preserved from getting crushed and fissured by increased pressure in working, or at any rate if all access of air could be cut off from it when so injured, its spontaneous combustion would be prevented. In the rare cases of quarrying an outcrop, the coal, as long as the over-burden can be removed, can be worked in successive courses or steps from the top of the seam downwards, and can thus be got whole throughout the entire thickness of the seam. If the over-burden be sent down the pit to serve as rubbish for packing the goaf in underground workings progressing simultaneously, the open-air working can be continued to a somewhat greater depth: at the risk however of finding that the deeper coal so reached has been already injured by settlement due to the underground operations.

When coal is got underground in successive courses or steps one below another from the top downwards, no packing in the goaf, not even were it masonry, will entirely prevent settlement of the superincumbent mass, whereby the coal in the lower and later-worked steps is always more or less crushed. A partial remedy consists either in packing with rubbish of a clayey nature, which consolidates into a more compact mass; or in leaving a sufficient thickness of coal underneath the packing of the goaf in the topmost course, and afterwards getting out as much as possible of this thickness, by working backwards below it and packing the goaf of the lower working also; or again, in timbering the floor of each course so thoroughly as to form a roof for the subsequent working of the next course below. But these methods, besides being costly and yielding a low output with a large proportion of small coal, are not always successful in obviating spontaneous combustion: still less so when the goaf is not packed at all, but is left to fall in.

What has to be guarded against is an actual outbreak of fire; so long as the coal is merely heating, the small quantity of noxious gas given off hardly matters, and the only drawback is that the workings sometimes get inconveniently hot for the men. The longer all risk of firing can be staved off, the more possible will it be to adopt the mode of working that will yield the largest output at the lowest cost:—namely, in seams inclined at steep angles, by laying out the workings in successive stages or panels of great height (measured up the slope), which entails less expense for the preparatory operations of laying them open; several of these stages are then worked simultaneously, the getting of the coal being proceeded with in each stage from the bottom upwards, by a succession of horizontal courses of excavations. By this method the bottom courses in each panel feel the roof-pressure least, and yield a great quantity of large coal, which is won without difficulty, and with less risk of heating and firing. But in the uppermost courses the coal gets more or less crushed by the augmented pressure; hence, to avoid fire, there must be some limit to the total height of each panel, or rather to the number of courses contained in it, the bottom courses being of greater height than the upper. In a thick and well stratified seam of strong coal, containing not many partings, and inclined between 14° and 30° to the horizon, total height of each panel may be 26 yards, measured up the slope, and the height of the bottom course 8 yards. But in the main seam at Doyet, which though hard is of variable quality and too liable to fire, the height of the courses is only that of a single tier of timber props, say 2 to 3 yards. Here four courses can be got, and a fifth started, without any fire having broken out; only no course must be taken more than six month in getting, and all the goaf must be thoroughly filled in. Quick getting is indispensable for avoiding fire in seams that fire readily. Usually by the time the fifth course is reached, the broken coal it contains is already hot, and great care is needed to prevent its burning whilst getting; hence five courses would seem to be the general limit for the height of a panel. As soon as the third course from the bottom is being got in any panel, the getting can be started of the bottom course in the next panel below; if the working of the lower panel were begun sooner, that of the upper would be endangered by settlements.

Alike in laying out the roads and in getting the coal, care must be taken to avoid the formation of roof cavities, from which start cracks, that radiate through the seam: such cavities are most liable to occur at junctions of roads, and are to be guarded against by careful timbering, which must be well watched. Large

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*From "Other Selected Papers" of the Institution of Civil Engineers.

[1] The original article appeared in the *Bulletin de la Societe de l'Industrie Minerale*, 1883, vol. xii., pp. 43-89.

[2] It will be borne in mind that in many of the collieries in the Midland and other coal fields of France the seams are not only of great thickness, sometimes even more than 20 yards, but also inclined at steep angles, sometimes nearly vertical.—A. B.

cavities occurring in spite of the precautions should be cleared out, and then thoroughly filled in with good packing of small rubbish brought from above ground. Where gob-roads have to be kept open for working or ventilation, they should either be shifted so as not to run through the middle of the goaf, but along its margin; or else they should be walled thick enough with good packing impervious to air and moisture, particularly when used as air-ways. They should be kept at a safe distance from any crushed pillars that have been abandoned in working.

The advantages of packing the goaf with rubbish are, that the workings are thereby kept cooler, settlements are less extensive, pillars get less crushed and are therefore less liable to heating, and fewer dangerous roof-cavities occur in which an outbreak of fire would be difficult to extinguish. In packing composed of friable stuff, the smaller bits fill up the spaces between the larger: and, if of a somewhat clayey consistency, the whole compacts under the load into a solid mass impervious to air. Good packing of this kind should always be used in the bottom courses of each panel; then by the time the top course is reached in the next panel below, the coal will there be got under a roof as compact as solid sandstone.

Spoil got from stone-drifts should not be used for packing the goaf; the large blocks of stone are too hard to crush under any settlement overhead, and air can pass too freely amongst them. In working a panel where the bottom course had been wholly packed with spoil got from sinking a shaft and from driving stone-drifts, notwithstanding that the spoil itself was incapable of heating, the author found that pillars of considerable size, which had been left behind in the midst of this spoil because not worth getting, grew hot so rapidly as to be taking fire by the time the second course was finished and the third begun. It was only by then surrounding this dangerous goaf with small rubbish carefully rammed in, that the winning of the coal could be finished to the top of the panel. Some years later, when the working of the next panel below came in under the same place, similar trouble from heating had to be encountered. Hence the author regards any spoil got underground as so bad for packing the goaf, that it should never be used unless the precautions are taken to pick out of it all stuff that could burn, and even then to keep it clear of contact with any masses that can heat. It is indeed by no means a dead loss to send up all such spoil to bank, and throw it over the tips, where after two or three years' exposure to the atmosphere it may, if meanwhile prevented from burning, become good enough to send down again into the pit for use as packing.

The best packing of all consists of loamy earth, and surface strata more or less disintegrated; the former is necessary wherever access of air has to be stopped at once without waiting for the roof to settle down heavily upon the packing. Where the goaf is well packed with good stuff; timbers, whether upright props or roof-slabs, can be left behind to become crushed by the load and buried in the packing; otherwise they should be removed, even if only partially, as a precaution against fire. By way of rendering the rubbish-tips at the surface sooner ready for use at packing, it is sometimes thought desirable to let them burn as freely as may be. But this opinion is not shared by the author, who considers that not only will a tip take a very long time to burn through to middle, but that, after the fire has all burnt itself out, the ashy stuff will be too light, too dusty, too hot, and not binding enough, to be suitable for sending underground. Nevertheless even such burnt rubbish is preferable to spoil got underground and packed there at once.

Ventilation by a forced current of air under pressure has been found by the author to be favorable to spontaneous combustion. Whether compression or exhaustion be employed, the greater the difference of pressure between the entering and the return air-currents, the more readily will the air penetrate cracked and crushed coal, and thereby promote heating and firing. In this respect, sharp turnings or narrowing of roads, and air-doors situated in a strong current, in the midst of crushed pillars or badly packed rubbish, are sources of danger, as are also inclines rising steep, and up-cast pits. Hence, whenever an inlet air-way runs at all near a return air-way, the intervening pillars or ribs of seemingly solid coal require specially careful watching.

The coolness of the air-current is practically of no value for preventing, though it may somewhat retard, the heating of cracked pillars, or of broken coal that has fallen from roof-cavities or elsewhere. In a colliery where an old drift 4½ yards long, from a shaft to an inlet air-way, had been closed with rubbish carefully packed, the subsequent settlement of the packing had left a space above, into which a little crushed coal had fallen from the roof; the coolness of the ingoing air did not prevent this slack from heating and beginning to burn; and it had to be all cleared out, and earth rammed in its place.

A return air-current should never have to go downhill, otherwise it accumulates heat and moisture at the upper end of the descent, thereby favoring spontaneous combustion at that place. Where distant workings are liable to be insufficiently ventilated, owing to negligence in maintaining former roads now used as air-ways only, fresh air should be supplied direct to them, either by splitting the main ingoing current, or by sinking a new shaft from the surface. It is better to split the air than to course a single current through too great a length, because the latter means greater difference of pressure, attended with more risk of fire.

At the Doyet collieries, wherever the seam is not thick enough to work by the foregoing method of horizontal courses, and where the expense of laying out the workings on that method would be too great, the plan is followed of getting the coal in inclined courses, that is by pushing the working faces forwards uphill along the slope of the seam, instead of horizontally along its strike. The uphill courses however are more difficult to keep open, and are liable to worse falls; each course takes longer to get, so that the surrounding crushed coal runs greater risk of heating, and this risk is further enhanced by the augmented draught consequent upon the air-current passing up the slope from the lower to the upper end of the course; hence fire breaks out more readily, while it is also more difficult to contend with on the slope than in horizontal workings. On the other hand, the rather larger quantity of packing used in uphill than in horizontal courses is an advantage against fire.

Firing of slack-heaps above ground can be effectually obviated. In the author's opinion, only by completely precluding all penetration of air into them. To ventilate them, with the idea of keeping them cool, he considers as ineffectual and as dangerous as to let air penetrate crushed coal in the pit. From experience of its success in smothering fires on the sloping banks of outcrop workings, he recommends the expedient of covering the slack-heaps with a layer of refuse slimes from the coal-washers. Such a covering, being coaly and not clayey, does not set hard and crack, but follows readily any subsidence of the stuff beneath it. A layer 12 inches thick he believes would be an ample protection against firing, or even heating; and he suggest that on shipboard spontaneous combustion in coal cargoes might be altogether obviated by a layer 6 inches thick, the coal being so stowed as to prevent the covering of slimes from disappearing into the interstices. To prevent spoil-tips from firing, the stuff should be tipped in a layer too thin to heat under the action of the air; and should be left long enough exposed, before tipping the next layer over it; if it be also freed beforehand from all coal that can be utilized, so much the better.

THE SIMPLON TUNNEL.

The following details of the proposed Simplon Railway are taken from a description furnished by a correspondent at Geneva. It is one of two schemes involving a sub-Alpine tunnel, the rival scheme being one for piercing Mont Blanc. Railway lines both on the north and south sides of the Simplon are already completed. The tunnel which it is proposed to pierce through the Simplon will be not far short of eighteen miles in length, and consequently the longest tunnel in the world.

The first practical steps towards the commencement of the work may be said to have been taken during the winter of 1876-77, when experiments were carried out with a view of determining, both on the Swiss and Italian side, the amount of hydraulic force that would be available for the boring machines as well as for purposes of ventilation. On the Swiss side this force will be derived from the waters of the Rhone, and on the Italian side from the Diveria. These experiments, which were continued in 1882, tended to prove that even in the depth of winter, when the motive power is at its lowest, the engineers will have at their disposal at each end of the works hydraulic forces equal to about 6,000 effective horse-power. It is calculated that this force will not only enable them to pierce rapidly, but that an efficient system of ventilation can be maintained. On account of the great length of the tunnel this question of ventilation is one of importance.

At 6,500 metres from the north head of the tunnel a shaft will be sunk about 1,000 metres in depth, and slope at an incline of about 45 degrees. At 5,300 metres from the south end a similar shaft will be sunk, having a depth of 680 metres. The bottoms of these two shafts will be connected by a vaulted gallery several metres above the line of advancement of the tunnel. As the work of boring proceeds an opening will be effected between the tunnel and the gallery, and consequently there will be a direct communication with the outer air. As the workmen cut their way further into the earth, a new opening into the gallery will be made over them, and the one behind will be closed. The men will thus always have over their heads a shaft through which the foul and poisonous gases will escape. As it frequently happens, however, especially in the high Alps, that under certain atmospheric conditions, the upper air becomes so dense that the gases from the earth do not rise quickly, it will be necessary to have at the head of each shaft mechanical arrangement which may be described as a series of gigantic suckers, these suckers will be constantly at work drawing up the foul air, while at the openings at each end of the tunnel hydraulic power will ceaselessly pump in fresh air. By this system it is expected that the temperature will be kept down to a fixed point, and a comparative state of atmospheric purity maintained. Should it be found on application that the arrangement described is insufficient to obtain the desired object, the temperature will be lowered by running streams of iced water, and large quantities of quicklime will be introduced into the tunnel to absorb the humidity of the air. It is also decided that the electric light shall not only be used for all purposes of illumination, but that the locomotives necessary for drawing the wagon loads of debris shall derive their motive power either from compressed air or electricity.

To obtain the easiest declivities on the Italian side, where there is a great fall, the south end of the tunnel will debouch at the lowest altitude possible. Consequently there will be a very steep incline from the centre of the tunnel towards the south. The north end will debouch in the alluvial plain formed by the deposits of the Rhone, exactly opposite the little village of Masseggen, and at an altitude of 689 metres above the sea. This end will be about an eighth of a mile from the present station of Brigue. Subject to variations in the plans which further study and surveys may suggest as being advisable, the following is a description of the line as planned by M. Meyer, chief engineer of the company. Leaving Brigue, it will pass through a short tunnel and rise to the entrance of the great tunnel, which, as already stated, will be opposite the little village Masseggen. At 6,000 metres from the entrance it will pass under the valley of the Gauther, near Berisal, the pleasant little village so well known to summer tourists who cross the Simplon. This same valley of the Gauther bears a very evil reputation for avalanches. The train, however, will have nothing to fear from avalanches, as it will, at this point, be 700 metres, not far short of half a mile, below the surface of the earth. Near the culminating rise in the tunnel, and when some distance to the north-east of the position of the Hospice, the frontier between Italy and Switzerland will be crossed. And here the traveller will have above his head the mighty mass of Monte Leone, 11,696 feet, with its glaciers, one of which is pierced by a gallery at the present day, to allow the road to pass. From the culmination there will be a long run, all down hill, to the south opening, above the village of Iselle. From the south end of the tunnel to where the line will join the Italian railways, there will be thirty-five tunnels, having a total length of 9,667 metres, or a little over 30 per cent. of the entire length of the line. The shortest of these tunnels will be 40 metres, and the longest 2 kilometres 40 metres. Several of them will be simply galleries cut through projecting rocks. There will be twenty-three viaducts measuring in the aggregate 1,423 metres, or nearly 5 per cent. of the total length of the line. The length of these viaducts varies from 23 metres to 136 metres. There will be twenty-four signalling stations placed at intervals of about 1,300 metres, and numerous passenger stations at short intervals. From Domo d'Ossola the line will run due south as far as Piedimulera. It will then turn east to Pallanza, on the north-west elbow of Lake Maggiore. Thence it will skirt the lake to Arona, where it will connect with the Italian lines.

THE City Engineer of Cincinnatti presented, on March 5, plans and estimates of cost of filling up above "high water mark" of the low shore occupied by the wholesale and other important business interests of Cincinnatti. The report estimates the raising of Main St., 12 ft. at $500,000; there are 20 such streets, and as many cross streets that would require raising, aggregating in total cost $20,000,000. The amount of the estimate will probably dispose of the question until another flood raises it again.

Stone Work and Brick Work for Post Office and Custom-House at Peoria, Ill.

The following bids were opened by the Supervising Architect February 25, 1881:

STONE WORK.

Peter G. Straub & Co., $35,900, 8 months, Ohio blue; $37,-900, Ohio buff.

Smith, Sargent & Co., $37,897, January 1, 1885, Illinois sandstone: $38,483, Missouri sandstone, blue; $43,722, Amherst sandstone.

E. R. Brainard & Co., $38,944, 18 months, sandstone.

W. D. Collingwood, $41,317, 9 months, Ohio blue sandstone; $42,700, Amherst buff.

M. A. McGowan, $41,900, 14 months, Michigan buff; $43,-569, Berea; $45,633, buff Amherst.

David Robertson, $45,500, 15 months, blue or buff Amherst.

Henry Furst, $48,300, 15 months, blue Amherst; $49,250, buff Amherst.

Valentine Jobst, $50,800, 17 months, blue Amherst; $51,-903, buff Amherst.

Jacob Veihmeyer, $52,000, 18 months, McDermott and Berea.

Ballance & Jans, $56,730, Berea; $58,490, buff Amherst.

Boldenwick & Heldmaier, $55,000, blue Columbia; $56,-200, Amherst buff.

A. J. White, $56,340, 18 months, Berea sandstone; $58,-600, Amherst buff.

Lakeworthy & Menke, $54,800, 18 months, Missouri sandstone; $65,500, Ohio blue sandstone; $68,500, Ohio buff sandstone.

Belknap & Dumesnil Stone Company, $70,625, 18 months, Amherst blue or Berea: $73,125, Amherst buff.

Thomas Osborn, $76,345.

Y ung & Farrell Diamond Stone Sawing Company, $85,122, December 1, 1885, Amherst; $91,497, Wolf Lake sandstone; $114,120, Canada red sandstone.

BRICK WORK.

A. J. White, $16,772.
Jacob Veihmeyer, $16,985, 18 months.
Lakeworthy & Menke, $18,500, 18 months.
Smith & Sargent, $18,510, January 1, 1885.
M. A. McGowan, 13,532, 60 days after stone.
Thomas Osborn, $21,000.
George O. Cook, $21,000, 180 working days.
Angus & Gindell, $21,745.
Valentine Jobst, $21,900, 17 months.
Peter G. Straub & Co., $28,000, 8 months.

Metals, Bricks, Etc.

Schedule of bids opened February 19, 1884, at the Navy Pay Office, Washington, D. C., by Pay Director, T. H. Looker, U. S. Navy:

10,000 POUNDS VERY BEST REFINED INGOT COPPER.

Joseph L. Savage, 14⅞ per pound.
D. Babcock & Co., 16 per pound.
R. A Robbins, 15 15/16 per pound.
J. B. Kendall, 14⅞ per pound.
M. Lissberger, 16¾, 14½, 14¼ per pound.
Pope, Cole & Co., 14 5/16 per pound.

25 TONS SCOTCH PIG IRON, EGLINTON.

Joseph L. Savage, $24.50 per ton.
J. W. Buker, $23.25 per ton.
D. Babcock & Co., $29.50 per ton.
J. B. Kendall, $22.50 per ton.
M. Lissberger, $25.75 per ton.

500 POUNDS BANCA TIN.

Joseph L. Savage, 19¾ per pound.
J. W. Buker, 19¾ per pound.
R. Boyd, 20⅞ per pound.
D. Babcock & Co., 21⅛ per pound.
J. B. Kendall, 21⅞ per pound.
M. Lissberger, 22¾ per pound.

1,000 POUNDS SLAB ZINC.

Joseph L. Savage, 5¾ per pound.
J. W. Buker, 5¼ per pound.
R. Boyd, 5½ per pound.
D. Babcock & Co., 6¼ per pound.
J. B. Kendall, 5 per pound.
M. Lissberger, 5⅛ per pound.

5,000 FIRE BRICKS, MAURER'S NO. 1, HAND MADE.

Joseph L. Savage, $37.50 per 1,000.
R. Boyd, $51.20.
D. Babcock & Co., $60.
Borgner & O'Brien, $48.

3 BARRELS RESIN.

Joseph L. Savage, $2.90 per bbl.
J. W. Buker, 1¾c. per lb.
R. Boyd, $4.33½ per bbl.
D. Babcock & Co., $5 per bbl.
J. B. Kendall, 1½c. per lb.

All of the above are to be delivered before March 11, and the awards will be made in a few days.

Bids for Steam Heating Apparatus at Mobile, Ala.

John Lyon, $3,586.65, 35 days, $150 more for chases.

Samuel J. Pope & Co., Chicago, $3,590, 50 days, $450 more for chases if first floor from screen is not heated; otherwise $3,680, and $3,820 if 48 inch boiler is used.

Bartlett, Hayward & Co., $3,748, and $775 for chases.

John Davis & Co., $3,907, and $874 for chases.

Edward E. Gold & Co., $4,225, and $650 for chases.

John D. Washburn & Son, $6,750, and $550 for chases.

There is no money available for this work, and an award will not be made until an appropirtation is made or until it appears safe to apply $14,000 now on hand, being reserved for contingencies.

Iron and Slate Work of Stairways for Custom-House and Post Office at Memphis, Tenn.

Bids opened by Supervising Architect February 27, under advertisement dated February 2, 1884:

McHose and Lyon, $6,050, soon as desired.
Poulsen and Eger, $6,850, 3 months.
Snead and Co. Iron Works, $7,620, 4 months.
Cheney and Hewlett, $7,910.
Bartlett Hayward and Co., $8,300, 3 months.
Hough, Ketcham and Co., $8,718.24.
Phœnix Iron Co., $9,700, 90 days.
Merz Architectural Iron Works, $10,600, 4 months.
Manley and Cooper Manufacturing Co., $13,995, 5 months.

Buffalo Breakwater.

Bids for the extension of the Buffalo breakwnter were opened January 26, as follows:

Daniel E. Bailey, $85,095.
Louis Harbrecht, $89,715.50.
George Talbot, $95,384.
Wm. McRay and C. Whitmore, $91,444.
W. F. Wentz and J. L. Purple $72,305.20.
G. B. Allen and W. H. Baldwin, $109,950.90.
John Druar, $96,231.
I. Farnsworth, $91,881.
L. P. Smith and J. A. Smith, $93,303.50.
F. W. Knapp and E. Gillen, $87,723.50.
G. Peterson, $101,246.
A. F. Chapman and R. H. Canfield, $108,547.
C. E. Williams, $83,174.36.
C. Schwartz and C. Berner, $86,334.

Awarded to C. E. Williams at $83,174.36, as the bid of W. F. Wentz and J. C. Purple ($72,305.20) was informal.

Great Shoal Light-House Maryland.

Bids for furnishing the materials and labor of all kinds necessary for the completion of the metal work for this light-house were opened February 16, as follows:

West Point Foundry Co., $5,594.
Poole & Hunt, $5,224.82.
Phœnix Iron Co., $6,250.
Allentown Rolling Mills, $6,547.58.
J. W. Bissell, $6,923.
J. P. Morris & Co., $7,145.
Tanner & Delaney Engine Co., $7,450.
Jonson Foundry and Machine Co., $8,274.46.

Brickwork.

Bids for furnishing 900,000 brick for the construction of the Mosquito Inlet Light-house, coast of Florida, were opened February 16, as follows:

John Oldfield, $16, $17, $17.
W. A. Wheeler, $19.
J. A. Bowker, $18.10, $21.25, $30.50.

ANOTHER MOTOR. 1884

An announcement is made of the discovery of a new and remarkable motor known as "The Triple Thermic Motor." The new motive power is the vapor of bi-sulphide of carbon. It has been in practical use in driving a 60-horse power engine for six months past in a cement paving manufactory on West Forty-sixth street, New York. The discoverer of the means of applying the new power and the machinery adapted to its use is W. S. Colwell, formerly of Pittsburg, who, it is stated, has been at work many years on their application. The material from which the vapor is generated, bi-sulphide of carbon, is a discovery of the last century. The force and power of the vapor in its application far surpasses that of steam, and its application and regulation are already under a more perfectly safe control than those of steam. The invention or discovery consists in evolving bi-sulphide of carbon into a vapor for operating machinery by generating heat in a generator and transferring it into a vessel containing bi-sulphide of carbon. The latent heat of the steam is utilized to convert the bi-sulphide of carbon into vapor, only 118° being necessary to produce this vapor. A prominent engineer of Chicago, in giving the result of his examination of the new motor, says: "I saw a 15-horse power boiler, with very little fire under it, generating steam, which generated the new motor, which in turn ran an engine of 60-horse-power." A syndicate has been formed which controls the invention and all its patents, with a capital stock of $25,000,000, of which $6,000,000 has already been realized on stock. Ex-Governor Hubbard, of Texas, and Ex-Collector Baird, of Boston, are mentioned as being largely interested in the new motor syndicate.—*Ex.*

THE Olmstead, Ill., Electric Light and Power Company, composed of Messrs. A. O. Pray, George A. Pillsbury, W. H. Beach and J. O. Beach, filed articles of incorporation with the Register the other day. Their capital stock is $500,000.

SELECTED MISCELLANY.

THERE were 23,310 houses built in London and the suburbs in 1882, forming 508 new streets and one new square, and covering a distance of 75½ miles.

A WHITE oak tree, which was used as a corner found in surveying the original line between the towns of New Boston and Weare in 1735, is still alive, and bears the old iron plate, with date still vissible.

A PROJECT for a great American Exhibition in London is on foot, to be given May 1, 1885. Gen. C. B. Norton, of the Centennial, Paris and the late Boston Exhibitions, is the manager and has already issued circulars to interested parties.

THE hottest place on record is said to be in the town of Bourke, 500 miles back of Sydney, Australia. The average for the first 15 days of last January was 110.06° F. in the shade; on January 15, the thermometer went to 122°.

GEN. NEWTON, in a recent interview, says the excavation of Flood Rock, in the East River is practically finished. All that is needed is the money, some $420,000, to furnish the 200,000 pounds of dynamite or its equivalent, needed to complete the work. He cannot say when the appropriation will be made.

HERR C. SCHNEIDER, of Dresden, has invented a dry galvanic battery. It consists of two cylinders, the larger one of copper and the inner or smaller one of amalgamated zinc. Both cylinders are open at each end, and the space between them is filled in with a mixture of plaster of Paris and a saturated solution of chloride of zinc containing 7 per cent. of chloride of sodium.

STATISTICS just collected by James M. Swank, Secretary of the American Iron and Steel Association, show that the total production of iron and steel rails in this country last year was 1,360,694 net tons, a falling-off of 20 per cent. as compared with the production of 1882. Of the total production last year 1,286,554 tons were Bessemer steel rails; 9,180 tons were open hearth steel rails and 64,954 tons were iron rails. The production of 1882 was divided into 1,438,155 tons of Bessemer steel rails, 22,765 tons of open hearth steel rails, and 237,874 tons of iron rails. The production of iron fell off 162,-920 net tons.

THESE are some of the results of the exploring expedition conducted by M. Alphonse Milne-Edwards, at the instance of the French Government, in the Atlantic Ocean on board the Talisman. They were communicated at a recent meeting of the Academy of Sciences, Paris. The ocean to the west of Morocco and the Desert of Sahara is of almost uniform depth. Fish abound at a depth of 1,000 to 1,300 metres. Between Senegal and the Cape Verde Islands the nets of the exploring party reached a depth of from 3,200 to 3,655 metres and brought up many living specimens which have not hitherto been known to exist elsewhere. In these depths the fecundity of life is prodigious, and at one draught as many as 2,500 fishes were captured.

CONSUL POTTER at Crefeld, says of Krupp's Steel Ordnance Works at Essen: "The forging process requires vast arrangements on account of the immense weight of the pieces which are to be handled, one of which sometimes weighs more than sixty tons. The steam hammer now in use for this purpose, weighs fifty tons, and has a stroke of ten feet. Another hammer is being constructed, weighing about 150 tons, which will cost over $2,500,000. Mountain guns are finished in two months, while two years are required to manufacture a 16-inch gun of 35 calibres length, 55 feet long, and weighing 121 tons. Mr. Krupp is now constructing ten guns for the Italian Government at a cost, it is said, of 894,000 francs each, for the purpose of coast defence. Particulars regarding weight and measure of these guns are not yet made public, but it is ascertained that they will send a projectile weighing considerably more than a ton through any armor which a ship can carry and float in an ordinary sea. It is also said that the Chinese Government has ordered guns for coast defence and naval purposes, of similar diimensions and power, which are in process of construction at this time by Mr. Krupp, who has already furnished that Government with 425 cannon of less weight, and since June last has been engaged on a contract for 450 more of his powerful steel guns."

IRON RAILWAY TIES IN GERMANY.

Translated for ENGINEERING NEWS from *Le Genie Civil*.

M. Jungbecker, Inspector of Construction and Maintenance of Way on the Bergisch-Markisch railway in Germany, has published a work upon the subject of Iron Railway Ties, from which we glean the following notes:

At the time of the Paris Exposition of 1867, the Bergisch-Markisch Co. laid down 664 ties of the design shown in Figs. 1 and 2, between the stations of Schlebusch and Mulheim; these

ties were 7 ft. 2½ in. long, weighed 62¾ lbs., and were laid 2 ft. apart, in a well drained sand ballast.

During the first three years this road behaved well, the traffic over it was no more noisy than that over our wooden ties, and the repairs were neither more difficult nor expensive. The one apparent fault was the want of a firm connection between the rail and its support. This resulted in an enlargement of the holes, and in cracks in the ties, and the abandonment for the time being of the Vautherin system of ties.

In 1874 the question of iron ties was again taken up by the same road; 25,000 were put down in the valley of the Ruhr, between the stations of Schwerte and Wickede. They were similar to the original Vautherin design, excepting that the centre of the upper plate was thickened to obviate the wearing in the holes, as shown on Fig. 3. More care was also paid to proportioning the material using in clamping, and with better results than before. This way has now been in use eight years, the original ties being, for the greater part still in place. The grade is about 33 ft. per mile and the curves 1312 ft. radius; there are good conditions without doubt, but the ballast is poor, being sand mixed with clay.

The defects observed on the original way between Schlebusch and Mulheim, the cracks in the ties and the working at the points of attachment, were likewise apparent in this track, during the first year, but they were much less important.

With the experience thus obtained, in 1877 a type of tie, shown in Figs. 4 and 5, was adopted. The form was the same but stouter, and a section of "T" iron was rivited below just under the rail to stop the flattening or spreading of the tie. This T iron did not fill the requirements of the case, and in the end the ties cracked as before. The next attempt was to rivet an angle iron to the underside of the upper plate of the tie, as in Figs. 6 and 7, cut to fit the section of the tie.

Progress was being made without doubt, but it was necessary to experiment with some hundred thousand ties, before it was possible to locate the exact strains producing the bad results referred to. Careful observation of the ballast proved that this material had a provoking tendency to leave the underside of the tie. The obliquity of the sides facilitated this squashing out. To prevent this escape of ballast and the consequent loss of lateral stiffness and resistance, the two small flanges on the base were first removed, reducing the width of the base of the tie; these were replaced by two vertical sides which confined the ballast, facilitated the tamping and stopped the creeping due to the passage of trains.

The Figs. 8 and 9 show the first and Fig. 10 the second type adopted in 1879 upon the Bergisch-Markisch railway; and with this tie the historical sketch ceases.

Before entering further into the details of metallic ties in Germany, it should be remarked that one of the great elements in its success was the use of mild steel (*flusseisen*); a metal called iron by some and steel by others. By whatever name it is called, its perfect homogenity, its great resistance and its extreme ductility, render it a precious material for all the constructive requirements of a metallic railroad tie.

In laying a roadway of the kind in question, the requirements are about the same as for properly laying wooden ties; the roadbed must above all be well drained. In Germany the rules under this head require that the most severe frost should never touch the bottom of the water level or drainage; to obtain these conditions, the drainage must be as low as possible and the ballast be completely permeable. With metallic ties there should be at least 8 inches of ballast under the tie.

The ballast found to answer best, was of stone broken to pass through a ring about 1½ inches in diameter. In want of this material, coarse gravel or water-worn pebbles from the beds of rivers, was used.

The section of tie finally used on the Bergisch-Markisch Railway, is represented in Fig. 10, and in elevation and plan by Figs. 11 and 12. The central reinforcement gave ½ in. of thickness at this point under the rail. The attachment of the rail is the delicate point in the designing of an iron tie. This tie is 7½ ft. long, and about 2½ in. high; it weighs 99 lbs., or filled with ballast well packed, from 165 to 171½ lbs.

M. Jungbecker estimates the cost of metallic ties at from $32 to $34 per ton; while creosoted wooden ties are worth in Germany from $1.40 to $1.50 each. With a weight of 99 lbs. each, at the above price, a comparison between the iron and wood would stand as follows:

Metal ties @ $32 per ton	$1.44 each
" " @ $34 "	1.53 "
Wooden ties	$1.40 to 1.50 "

The gain in durability and stability would more than compensate for the increased cost of the metal tie.

Fig. 11 shows the manner of giving the inclination to meet the rolling plane of the car wheels by a slight camber in the tie. As shown in this same figure, the end of the ties are enclosed by vertical walls, completely confining the ballast under the tie.

Figs. 13 and 14 show the manner of laying the ties for rails of 21 ft. 4 in. and rails of 29 ft. 6 in. in length. The rail adopted with these ties weighed 75½ lbs. to the yard.

As before remarked, these ties were made of mild steel; test bars had to stand a tension of 64,000 lbs. per square inch, with an elongation of 15%, and furthermore the ties were required to be bent without crippling, so that the edges in cross-section, would touch each other, and the maximum radius at the fold be 3 in.; this required an excellent metal.

The method of manufacture of these ties is very simple. They leave the rolls in 3, 4, or 5 lengths, and are at once cut up by a saw. After being re-heated a machine turns down the ends and at the same time gives the ties the required camber. As soon as cold they are drilled and are then ready for use. The smaller fastenings are made of tough iron, and shaped with much exactitude.

M. Jungbecker makes the following comparison between a lineal *metre* (3.28 ft.) of ordinary wooden tie construction and a *metre* of metallic roadway:

STEEL RAIL AND WOODEN TIE. (Rail 21 ft. 8 in. 67 lbs. per yd.)

43.3 ft. steel rail, 968 lbs.	@	$38.80 per ton	$17.00
2 pairs of splice plates	@	.68	1.36
8 bolts and nuts	@	.04⅜	.35
† oak ties	@	1.50	10.50
14 chairs	@	.07	.98
28 clamps			.34
			$30.53

(Almost $1.41 per lineal foot of track.)

STEEL RAIL AND METALLIC TIE.

Rail, as before	$17.00
Splice plates	1.36
Bolts	.35
7 metallic ties @ $1.42	9.94
14 sets of clamps	1.13
	$29.78

($1.37⅞ per lineal foot of track.)

With a 29 ft. rail the price is practically the same. The important fact to note in the comparison, is the price of $1.42 for the metal tie. This, with a weight of 98 lbs. is only $32 per ton. This price is without doubt low, but the metallic tie should be allowed the benefit of the reduction in the cost of manufacture of this new article, a reduction which will surely follow as the manufacture increases.

Sufficient time has not yet elapsed, since the laying of the last adopted type of tie, to enable us to make an absolute and definite decision as to the advantages of this new way. But we can nevertheless review some of the points already studied.

First.—In regard to rusting. Railway engineers have long recognized the fact that with rails in use in the track, the rust is almost imperceptible, while if stored in the open air the oxidation is very apparent—the old rails returned to the mills are generally exempt from rust, and when a certain yellow tint does appear, the oxidation is very superficial. In this connection it is interesting to note that the iron ties, notwithstanding their thinness and large surface, are as free from rust as the rails in use. In spite of some bad ballast, in the eight years of their use, not a single tie has yet failed from rusting out. In wet tunnels, however, where the air circulation is bad, the oak tie should still be used, or some preservative covering put on the metallic tie; in the ordinary track no such protection is required.

Under the bottom of the rail, at the place where it is fixed to the tie, a continual hammering takes place, due the vibrations from the passing wheels, this results in a polishing of the surface, with a wear rarely exceeding $\frac{1}{32}$ in. in depth. This action is chargeable to the want of rigidity of attachment, and to remedy the evil the cause must be removed.

As to breakage; the number had not exceeded 172 in 273,900 ties, at the time of making the report. Much of this damage was due improperly proportioned fastenings; a fault afterwards corrected. The rupture generally took place soon after the ties were laid, and as the makers guarantee them for two years, the railway company was at no loss.

The smaller fastenings (*Befestigungs material*) are also subject to some deterioration. Iron of a tough structure should be employed in these; the vibrations due the contact of metal with metal, under the conditions of use, hardens or granulates the metal.

The behavior of these metalic ties in the case of derailment has been studied. In the first experiments, the ballast was badly tamped, and the ties were seriously damaged. With a more solid support to the ties and a better roadbed, of 62 ties effected by the derailment, 13 showed some small cracks, and 47 were deformed, but not to such a degree but that they could be straightened again without trouble. In the first experiment mentioned, in 24 damaged ties 12 were broken, and 30 wedges and 5 clamps either twisted or sheared off; all of them had to be replaced by new ties.

M. Jungbecker concludes as follows:

First.—That metallic ties should be simple in construction presenting no difficulties to the rolling process. They should be finished entirely by the machine; and rolled like rails, avoiding riviting and other expensive processes.

Second.—The cost of putting down a metallic way exceeds very little that of an ordinary road; and this increased expense is more than compensated for by greater durability. It should not be forgotten that the taking up and laying down of ties represents a large sum annually in railway expenses. The old iron tie is worth five times the value of an old wooden tie; and supposing that the new iron tie cost twice as much as the wood, the iron tie would still have an advantage of 25%.

Third.—The expense of laying and taking up these iron ties does not exceed that with wood.

Fourth.—The metallic ties are a greater security in the working of the road; the growth of traffic has made necessary the employment of heavier rolling stock, and as a consequence, the wooden ties must be frequently renewed.

Fifth.—Metallic ties are a natural accompanyment of the 250 to 300,000 tons of steel rails annually exported from Germany, and would form a new article of exportation. In Italy, Spain and Portugal, where wood is scarce, and which countries now receive the greater part of their rails from Germany, the iron tie must sooner or later be used.

Sixth.—In case of war, iron ties favor the rapid construction of railways.

Sections of the different types of metallic ties adopted on the principal German railways are shown in Figs. 16 to 22.

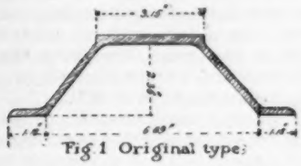


Fig 1 Original type.

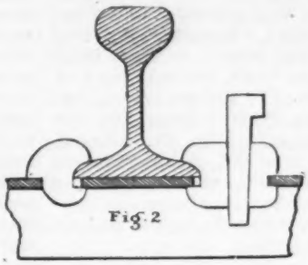


Fig. 2

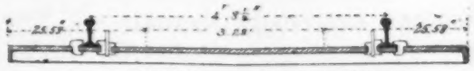


Fig 11 Longitudinal sec. of Tie.

Fig 12 Plan.

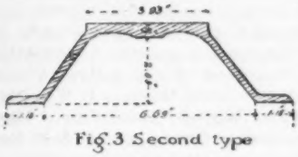


Fig. 3 Second type

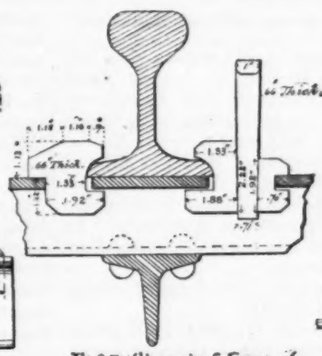


Fig. 5. Showing form of fastening adopted in 1877, and since practically adhered to.

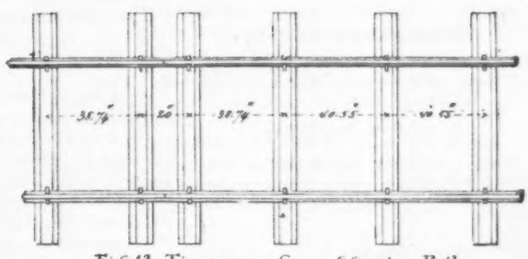


Fig. 13 Tie-spaces for a 6.5 metre Rail.

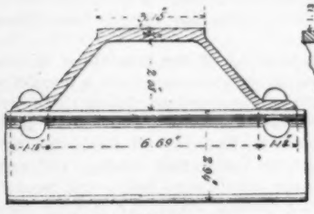


Fig. 4. Third type

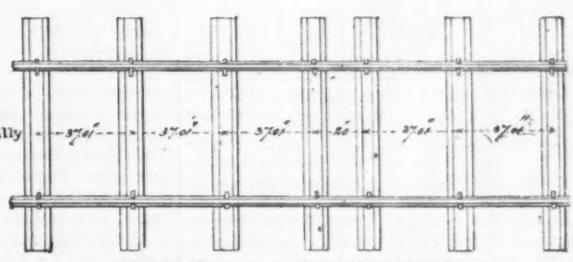


Fig. 14. Tie-spaces for a 9 metre Rail.

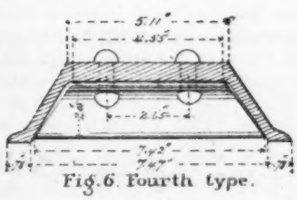


Fig. 6. Fourth type.

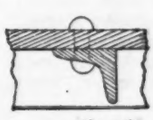


Fig. 7.

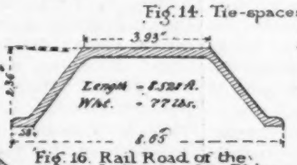


Fig. 16. Rail Road of the Left bank of the Rhine

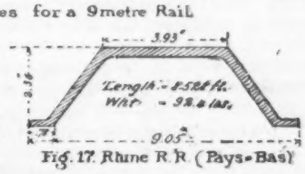


Fig. 17. Rhine R.R. (Pays-Bas)

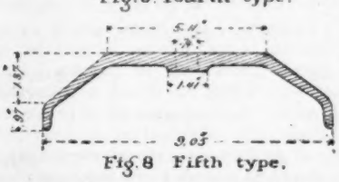


Fig. 8 Fifth type.

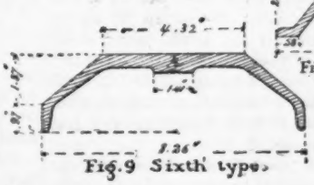


Fig. 9 Sixth type.

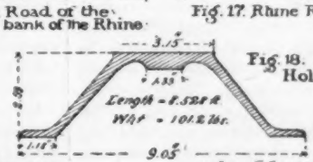


Fig. 18. Holland Railways.

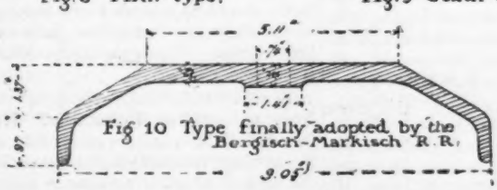


Fig 10 Type finally adopted by the Bergisch-Markisch R.R.

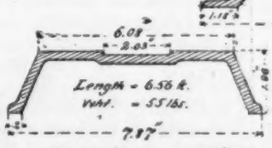


Fig 19. Amsterdam R.R.

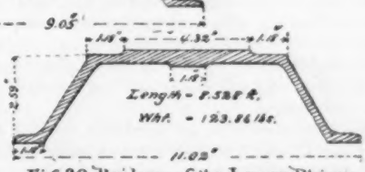
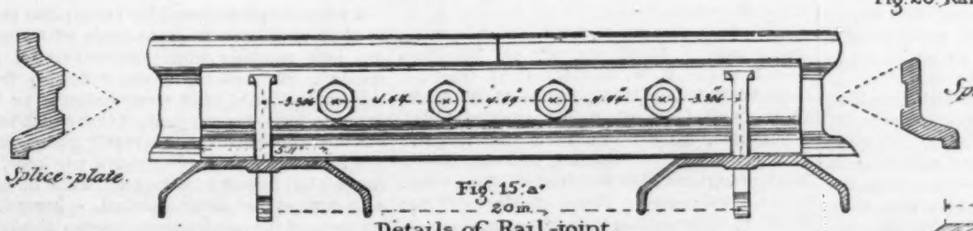


Fig. 20 Railway of the Lower Rhine.



Details of Rail-joint.

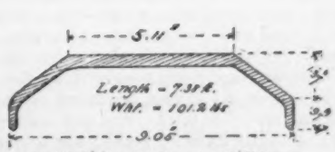


Fig 21 R.R. right bank of Oder.

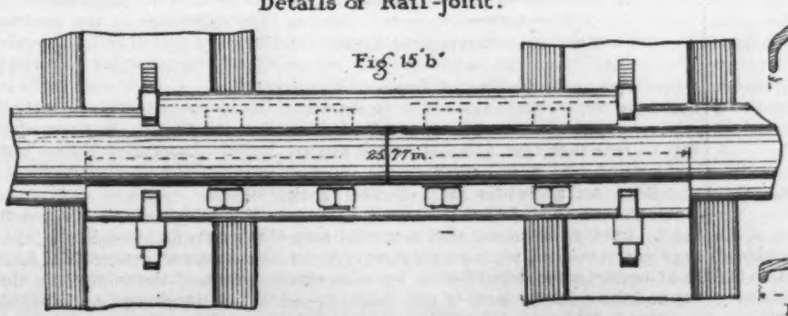


Fig 22. Prussian State R.R's.

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TABLE OF CONTENTS.

	Page
Spontaneous Combustion in Collieries	109
The Simplon Tunnel	109
Bids for Buildings, etc	111
Another Motor	111
Selected Miscellany	111
Iron Railway Ties in Germany	111, 112
To Chief Engineers and Contractors	114
The Engineers' Society of Western Penn'a	114
American Society of Civil Engineers	114
New York State Survey for 1883	114
Personals	115
New Publications	115
Correspondence	116, 117
History and Statistics of American Water-Works	117
Water	118
News of the Week	118, 119, 120
Iron and Metal Markets	120

To Chief Engineers of Cities and Railways.

The superior merits of Engineering News as a medium through which to gain the attention of contractors is so universally conceded that it is hardly necessary for us to emphasize the statement. As a *journal of construction* it has persistently held to its way amid many discouragements, until it has now its well merited recognition by the contracting class of business men. We unhesitatingly assert that Engineering News is read each week by more contractors than is any other single journal in America. It is reasonable that it should be since it is the only journal that reports at all largely a great variety of construction work. Railways, canals, sewers, water-works, river and harbor improvements, dredging, streets, gas, building, docks, bridges, stone-work, engines—wherever there is a chance for a contractor to put in a bid, that work we publish if we consider there is time for it to get to our patrons before opening proposals.

We are continually pushing this class of advertising, and we solicit the patronage of City Engineers and the Chief Engineers of railways and all engineers who control the letting of valuable contracts. Give our journal a trial; our price is low, while we go direct to the men whom it is desirable to reach.

There are many contractors with large plant, who can afford to take contracts at low rates simply because they are so well equipped; city engineers will find it to their advantage to bring these men into competition with the small, local and poorly equipped contractors; these latter will be so stimulated by the competition that in the end they will be the gainers by reason of learning improved methods of working, and thus both cities and contractors will eventually have no reason for complaint.

It costs but a trifle to advertise a contract letting; try our facilities and we are certain you will be well pleased.

The Engineers Society of Western Penn'a.

This society, one of the most vigorous of the different engineering organizations, outside of the American Society of Civil Engineers, in the country, held its annual banquet on February 28, at the Monongahela House in Pittsburg.

The President, Wm. Miller, presided, and seventy members were present; music was furnished by the Engineers' Quartette, and toasts were given and responded to as follows: "E. S. W. P," by Wm. Metcalf; "Still Life," by Max Livingston; "Bacteria," by Prof. Phillips; "Steel and Steal," by Thos. Rodd; "Our Ex-President," (Mr. Gottlieb) by J. L. Lewis; "Engineers," by Mr. Ackenheil; "Ore and Pig," by Wm. Thaw; "Water," by Geo. H. Brown; "Tunnels," by Mr. Burwell; "Breech-loaders," by Col. Mann; "Natural Gas," by T. P. Roberts; and the last toast "The Chroniclers," by G. F. Muller.

The banquet was a notable success and enjoyed by all participating.

The American Society of Civil Engineers.

A regular meeting of this society was held at their house on Wednesday evening March 5, Vice-President Paine presiding. Papers were read as follows: "A description of the chimney of the Pacific Mill, at Lawrence Mass.," built under the direction of Hiram F. Mills, C. E. and "The Chimney of the Merrimack Manufacturing Co., at Lowell, Mass., and the Chimney of the New York Steam Heating Co." by Chas E. Emery, M. Am. Soc. C. E. Considerable discussion followed.

The following persons were declared elected as members of the Society:

Members.—Frederick J. Carrel, First Assistant Engineer, Cascade Canal, Cascade Locks, Oregon; Samuel James Fields, Chief Engineer, Niagara Bridge Works, Buffalo, N. Y.; Asa Betts Fitch, Chief Engineer in charge of Location and Construction of Extension Terre Haute, and Logansporte R. R. Terra Haute, Ind.; Edmund Hayes, (Elected Junior, March 6, 1878,) Engineer Central Bridge Works, Buffalo, N. Y.; Albert Banks Hills, (Elected Junior, February 2, 1876,) City engineer, New Haven, Conn.; William E. Hoyt, Chief Engineer, Rochester and Pittsburg R. R. Rochester, N. Y.; Harry P. McDonald, Civil Engineer, Louisville, Ky.; Frederick Sylvester Odell, Civil Engineer, N. York City; John Henry States, Civil Engineer, Jersey City, N. J.; Christopher Columbus Wilcott, Civil Engineer, U. S. Navy Yard, Mare Island, Cal.

Junior.—Thomas Delano Whistler, Civil Engineer, South Orange, N. J.

A more complete report of the proceedings of this meeting will follow in next issue. The members present were: Vice-President, Wm. H. Paine; Secretary, John Bogart; W. E. Worthen, J. J. R. Croes, Wm. R. Hutton, Theodore Cooper, Chas E. Emery, G. W. McNulty, Jos. P. Davis, Geo. S. Greene, Jr., L. L. Buck, T. J. Long, S. S. Haight, O. F. Nichols, A. B. Paine, E. B. Noyes, C. C. Schneider, Alphonse Fteley, A. J. Frith, F. L. Griswold, Geo. H. Frost, Stevenson Towle, C. O. Brown, A. V. Abbott, F. C. Prindle, D. McN. Stauffer, J. G. Van Horne, T. E. Brown, W. G. Hamilton Wm. P. Shinn, F. W. Watkins, C. D. Watkins, Capt. W. E. Bixby, H. M. Nilson, C. W. Hunt, W. H. Atwood, H. W. Brinckerhoff and Wm. J. Haskins, all of New York and vicinity; Tho. C. Keefer of Ottawa, Canada; David W. Cunningham, Mandan, Dak. Visitors were: Messrs. Whittemore, Perez, of Mexico; Gay, W. W. B. Phinney and S. J. Johnson.

New York State Survey for 1883.

From the general report of James T. Gardiner, Director, we make the following extracts:

In referring to the origin of the State Survey, he says that Gov. Clinton, in his annual message of 1827, first expressed the want of an official an authentic map of New York State, and suggested that this want be supplied. In 1852 Gov. Hunt sent a special message on the subject, urging such a survey. In 1853 Gov. Seymour asked for an accurate survey and the establishment of permanent monuments; in 1875, under Gov. Tilden, the American Geographical Society of New York, through a special committee made a careful investigation of existing maps of the State of New York, and in their report showed them to be grossly inaccurate, that the main surveys were made by chains and compass 100 years before, and that the maps of the State were worse than those of any other Commonwealth. In response to these appeals made during a period of fifty years, the State Legislature finally took action and made an appropriation for beginning the work in 1876.

The question early arose as to the proper person for conducting the work; the office of State Engineer being of changeable tenure, it was deemed best to vest the power in a permanent unpaid commission, the highest in authority and experience that could be obtained. The Commission appointed under this ruling was composed of the following gentlemen: Horatio Seymour, William A, Wheeler, Robert S. Hale, William Dorsheimer, Francis A. Stout, George Geddes, and F. A. P. Barnard.

The general plan adopted and the progress made to date has already been given in this journal.

In treating of the rainfall of Western New York, the report shows, on a careful analysis made of observations taken since 1830 at the Rochester University, and by the U. S. Signal Service at Buffalo and Rochester since 1870, that from 1830 to 1880 during the very period that the woods were being cut from this section of the State, that the rainfall steadily *increased* from a mean annual fall of 27.7 in. to 38 inches. From 1868 to 1881 there was the greatest average rainfall in that locality—38.73 inches.

While the mean rainfall has increased, the summer flow of the streams has diminished. This is partly due to the loss of retaining power in the ground by the removal of the soft forest mold which stored the rains and melting snows, instead of permitting them to waste themselves in destructive floods; it is also partly due to an enormous increase in evaporation.

The proportion of rainfall, which owing to evaporation is lost for use in springs, lakes and streams, is known to but few. In the special report will be found a collection of observations on evaporations in this country and Europe.

They show that large rivers receive into the main channels seldom more than one-quarter of the average amount that falls on their water sheds. The remaining three-quarters is evaporated.

On small water-sheds the proportion of loss from evaporation is smaller. The average flow into Croton lake is about fifty per cent. of the average rainfall on the gathering ground, the area of which is 339 square miles.

A very complete record for twenty-two years is given of the flow from the basin of Cochituate lake together with observations on the rainfall. The amount of water flowing from this water-shed of 18.75 square miles is, on the average, forty-five per cent. of that which falls, but the proportion varies greatly from year to year. In 1866, only twenty-five per cent. of the rainfall flowed into the lake, while in 1857, with almost the same rainfall, seventy-four per cent. of the precipitation entered the lake. The difference in the amount evaporated in 1866 over that of 1857 was equivalent to a depth of 30 inches of water over the whole gathering ground. Experiments made in Denmark and England are quoted, showing that in the localities mentioned, the mean annual evaporation from soil and grass land is from 26 to 30 inches, or from fifty-six to sixty-seven per cent of the rainfall.

The tables of rainfall and flow of the Sudbury river and Cochituate lake show, also, that the summer evaporation amounts to eighty per cent. of the rainfall on these basins; and that in March and April all the rainfall may flow off, together with a large amount of water from melting snow accumulated during the winter.

The Sudbury river tables are especially valuable for determining approximately the proportion between the amount of rainfall lost by floods and that which passes off by evaporation.

They show that on this water-shed the loss of water by evaporation between May and December is from three to four times the quantity lost in spring floods.

The annual flow from the Cochituate watershed varies much more than the rainfall. From 1857 to 1858, the rainfall decreased 14.5 inches, but the off-flow was 30 inches less. The years 1858 and 1859 had the same rainfall, but the flow increased 19 inches. The rainfall, became greater by 6 inches in 1860, but the yearly flow diminished 19 inches. The next year, 1861, the rainfall was 10 inches less, but the flow was 6 inches greater.

The report says of woods as preventors of evaporation that they keep the surface cool, the atmosphere moist and the lower stratum of air so still that the powerful drying action of the wind is little felt.

The ordinary rule, deduced from European observations, is that streams draining wooded and swampy, basins will have an average flow equal to 60 or 80 per cent. of the mean rainfall, while streams draining undulating pasture and woodland will only receive from 50 to 70 per cent. of the rainfall. From this it would appear that the removal of the wood from a district means a loss of 10 per cent. in the flow of streams issuing from it.

The following is the only available comparison between wooded and unwooded watersheds, respecting their summer and autumn flow:

	Average rainfall from June 1st to November 1st.	Average flow from June 1st to November 1st.	Percentage of rainfall flowing in stream.
	Inches.	Inches.	
Sadbury River basin	20	2.9	14.5
West Croton basin...	22.5	8.3	37

With almost equal rainfalls, more than two and a half times as much water flows from the wooded basin of the West Croton as is discharged from the comparatively unwooded water-shed of the Sudbury river between June 1st and November 1st.

During the remainder of the year the discharge from these two water-sheds is almost the same:

	Rainfall from November 1st to June 1st.	Flow from November 1st to June 1st.	Percentage of rainfall flowing in streams.
	Inches.	Inches.	
Sudbury River basin	24.01	22.64	90
West croton basin...	26.10	26.00	100

The report concludes as follows, regarding the flow from water sheds, as relates to the drainage in Westson, New York:

The period from 1868 to 1881 was one in which the yearly yield, monthly and spring rainfalls reached the highest maxima recorded since 1830.

The annual average rainfall of the region since 1830 is 34 inches. The mean annual rainfall from 1868 to 1881 inclusive, was 38.73 inches. The maximum annual rainfall was, at Rochester, in 1873, 49.9 inches. The maximum annual rainfall over any large area has not probably exceeded 47.3 inches. The maximum monthly precipitation recorded is 8.7 inches. The greatest monthly rainfall likely to occur over any large area is 7.5 inches. The maximum daily rainfall recorded in the region is 3.23 inches.

The greatest precipitation at Rochester, in March and April together, was 11.73 inches, in 1873. The Buffalo precipitation at this time was, however, only 9.12 inches. 10.42 inches may therefore be considered a probable maximum March and April rainfall for the region. The combined rainfall of these months has never but twice exceeded 8 inches. It often reaches 6.5 to 7 inches.

The snow accumulated on the ground before March 1st not infrequently amounts to twenty inches. In melting it is equivalent to two inches of rainfall.

The total quantity of water to be disposed of during March and April may therefore often amount to 10 inches of rainfall over the whole surface of the water-shed in this district.

The maximum flow of streams under the conditions described is found to be in March and April. During these two months the water channels will be required to carry off the total rainfall, plus the water produced by the melting of snow accumulated before March 1st.

On unwooded areas, having the climatic and structural conditions of the region under consideration, the evaporation is so great that any channel capable of carrying off the spring flow is not liable to be flooded between May and November. The volume of water evaporated is so great that, on small watersheds, the summer flow is not likely to be more than twenty per cent. of the spring flow.

PERSONAL.

GUS. C. HENNING, M. E. has opened an office as an Inspecting Engineer, in New York.

A. A. ROBINSON is promoted to be General Manager of the A. T. & S. Fe R. R. and G. C. HARRIS, appointed Assistant General Manager.

A. S. WAGNER has been appointed superintendent of construction of the new public building at Williamsport, Pa.

JOHN MINOR has arrived at Portland, Ore,, to assume the general management of the Oregon Improvement Co.

ALBERT ASTINDEL, of Milwaukee, has been appointed General Agent of the N. W. Division of the American Express Co., with headquarters at Milwaukee. He succeeds E. M. Cooper, who recently resigned to become Gen'l Manager of the Wells-Fargo Express Co.

COLONEL JOHN NEWTON reported at Washington on March 5, and will immediately take charge of the Engineering Bureau; to succeed Gen. H. G. Wright, retired.

COL. R. E. RICKER, formerly General Superintendent of the Terre Haute & Indianapolis R. R. has been offered the General Managership of the Denver & Rio Grande R. R.; it is thought that he will accept.

ISAAC TODHUNTER, M. A. F. R. S., the well known English mathematician, recently died at the age of 64 years.

MR. JOHN EISENMANN, Professor of Civil Engineering in Case School, Cleveland, O., has been appointed Superintendent of Parks of that city at $2,000 per year. Prof. Eisenmann has seen considerable service on the Mississippi River survey.

A. S. THOMSON, whose resignation as chief computer of the Supervising Architect's Office takes effect April 1, has been granted leave of absence until that date. HERBERT VALE, of the same office, has been designated to act as chief computor till April 1, at which time he will probably be appointed to the office.

MR. HERMAN BARTELS, of Hamburg, Germany, is in New York as the agent of Mr. Brandt, whose hydraulic drill was described in our numbers of January 19th and 26th, 1884. This drill was used in the great Alpine tunnels under the supervision of the Imperial Austrian Engineers, and carried off the prize. Our contractors must look to their laurels, as Messrs. Brandt and Bartels propose to bid on all tunnel work offering, and especially the aqueduct for this city.

BRIGADIER-GENERAL HORATIO G. WRIGHT, late Chief of Engineers, U. S. A., was retired from active service on March 6th.

A. S. THOMSON, of the Supervising Architects office, at Washington, D. C., Chief Computor and Inspector of Buildings, has resigned his position after fourteen years service. He has made a more advantageous connection with the Potomac Red Sandstone Co., of Washington, D. C.

GENERAL ROSSER, of Minneapolis, according to a dispatch from that city, has been offered the position of Chief Engineer of the Nicaragua Canal, He sails from New York on March 8th, for Nicaragua,

SAMUEL M. GRAY, City Engineer of Providence R. I., and CHARLES H. SWAN, C. E. of Boston, Mass, sailed on the Servia on March 5, for Europe, there to investigate the sewerage systems of different localities and types, in the interest of the City of Providence, R. I. Both of the above named gentlemen are members of the Am. Soc. C. E.

The points to to be especially examined on the Continent are Dantzic, Hamburg, Berlin, Breslau, Frankford-on-the-Main, and Amsterdam. The investigation and filtration systems of a number of English and Scotch towns will be visited, and the chemical processes thoroughly investigated in other places in England; Paris will be finally visited. From this brief outline it will be seen that a great deal of real work is blocked out for this engineering commission; and from the reputation of the engineers and the general thoroughness with which Mr. Gray does all his work much good may be expected from this inspection and study of foreign methods.

NEW PUBLICATIONS.

ENGINEERS' HANDY-BOOK, containing a full explanation of the Steam-Engine Indicator, and its use and advantages to engineers and steam users; with formulæ for estimating the power of all classes of steam-engines; also facts, figures, questions, and tables for engineers who wish to qualify themselves for the United States Navy, the Revenue Service, the Mercantile Marine, or to take charge of the better class of Stationary Steam-Engines; with illustrations. By STEPHEN ROPER, engineer, author of "Catechism of High-Pressure or Non-condensing Steam-Engines," etc., etc. Seventh edition. 1884. E. Claxton & Co., Phila., publishers. Price, $3.50.

THE STEAM BOILER, its care and management; with instructions for increasing the efficiency and economy, and insuring the durability and longevity of all classes of steam boilers, stationary, locomotive, marine, and portable; with hints, suggestions and advice to engineers, firemen, and owners of steam boilers. By STEPHEN ROPER, engineer. 1884. E. Claxton & Co., Philada., publishers. Price, $2.00.

ROPER'S INSTRUCTION AND SUGGESTIONS FOR ENGINEERS AND FIREMEN who wish to procure a license, certificate, or permit, to take charge of any class of steam-engines or boilers, stationary, locomotive, and marine. By STEPHEN ROPER, engineer. 1884. E. Claxton & Co., Philada., publishers. Price, $2.00.

Mr. Roper is too well known as a writer of numerous text books upon steam engineering in all its varied ramifications, to need much further mention in connection with the above new editions of his popular works. We have already reviewed them, when first published, and can only repeat our then remarks, certifying to the eminently practical and valuable field covered by the author.

The "Handy-Book" is to the steam engineer, on land and sea, what Trautwine's "Pocket Book" is to the civil engineer; a vast accumulation of facts and figures, of value and interest to the seeker after information.

The treatise on Boilers and their management, should be in the hands of every one who is responsible for their care. And the Instructions and Suggestions are concise, practical, and to the point; and give, in a small volume, the substance of voluminous works.

CORRESPONDENCE.

HIGH WOODEN TRESTLES.

Special Correspondence Engineering News.

PHILADELPHIA, Feb. 21, 1884.

EDITOR ENGINEERING NEWS:—Your correspondent "Engineer" will find a description of some high wooden trestles under the article on bridges in Enc. Brit. and the Americana, published by J. W. Stoddart & Co.

L. M. H.

EARTHWORK PROBLEM.

Special Correspondence Engineering News.

TAMPICO, Feb. 15, 1884.

EDITOR ENGINEERING NEWS:—In a railroad cut the dimensions, all expressed in metres, btween two stations, 25 metres apart are recorded as follows:

St	Left.		C'tre.	Right.		Base and Slopes.	Area Sq.m
216	+0.52	+0.61	+2.13	+6.71	+6.76	Bs. 5½° met. slop. 1:1	24·10
	3·27	3·11		9·21	9·51		
217	+1.35	+1.41	+2.42	+6.08		" 5½° " " ½:1	21·42
	3·42	3·33		5·79			

Supposing the side slopes to undergo a gradual change in going from Sta. 216 (where it is 1:1) to Sta. 217 where it is ½:1) we ask:

1. Can the volume of the cut between Stations 216 and 217, properly be calculated by the Prismoidal formula?
2. What is the ratio of the side slopes half way between Stas. 216 and 217?
3. What is the area of the middle section?
4. What are the contents of the cut.

Please ask some of your readers to answer, and oblige,

Yours very truly.

"CÆCUS."

BRIDGE PROJECT OVER THE HUDSON.

Special Correspondence Engineering News.

PITTSBURG, PA., Feb. 26, 1884.

EDITOR ENGINEERING NEWS.—In your issue of February 23, 1884, a Bridge Project over the Hudson River at New York, is described and criticisms on the same invited.

Permit me to say a few words: The possibility and feasibility of the described method no one will doubt, having reference merely to its engineering aspect. The idea is not new and in a general way had been proposed for elevated railroads and bridges before (see U. S. patents, No. 222,374, No. 264,461 and others), though perhaps not on such a large scale.

There are, however, serious objections to the system, some of which are anticipated in your article. During fogs such a bridge would be a dangerous obstruction to navigation and during all other kinds of weather it would be a *partial* obstruction to navigation. It can safely be asserted that the navigation interests would not submit to such a plan, and *justly* so; for if modern progress in bridge engineering can boast of one thing more than another, it is its ability of safely bridging the widest, deepest rivers with very long spans, high above all navigation. Long approaches with easy grades are no obstacles for railroads and passable in every place. The continuity of track over a bridge admits of transportation without loss of time and of a vast amount of travel. This has, for large bridges, been found beyond controversion far more advantageous than a bridge crossing cut in two by a draw bridge. Now, a draw bridge does not offer as great and long interruptions to railroad travel as the proposed method would. Therefore, at a greater cost than a draw bridge (a self-evident fact) it would furnish poorer accommodations. Nor is this all. Extra motive power at extra expense would be required to move the platform from shore to shore. This motive power would not be less than for a large ferry boat, capable of the same kind of work at a vastly smaller capitalization.

Fog and ice are in the way only a small part of the year and even during such weather, straight ferry crossings can be operated with chain propellers, a system already tried abroad. This is the way a railroad would look at it.

The navigators as mentioned before, had for their interest at least as important as those of the railroads, a right to demand an unobstructed river, and in view of a 1600 ft. span over the East river would most likely insist on nothing less over the North river. 500 ft. spans may do for the Ohio river, but not for the North river, for modern and future needs.

The question of bridging the North river is not an Engineering question any more, but a financial question pure and simple. On the arrival of the time in which it will pay to bridge the river without interference with navigation in any way, it will be done.

And then when it is done, let us hope that over the North river may be built a bridge which will be a credit to the Nation and our times.

X.

ERRORS IN LEVELING LONG DISTANCES.

Special Correspondence Engineering News.

PHILADELPHIA, Feb. 26, 1884.

EDITOR ENGINEERING NEWS:—At what rate does the error in a long line of levels increase?

It is often, if not usually taken as proportional to the distance run—a certain number of hundreths per mile—and while I had supposed it to increase as the $\surd$ distance* the results on a number of lines leveled the past season do not confirm either view. The longest of these were about 39 and 27 miles respectively. Of the first of these, about 10 miles were run reading the road to hundredths only, and the circuit closed to within 0.02'.

The second line was not a complete circuit, but double turning points and two independent sets of notes were used throughout. In this way I could detect the increase or decrease of *errors of observation*, by the change in the difference between my calculated heights of instrument. Now, while in about 650 "set ups" the average variation between any two consecutive H. I's., was perhaps 0.002, the total difference was in no part of the line greater than 0.051. [See diagram.]

In another case two parallel lines were leveled independently but with occasional checks, with rate of error in complete circuits as follows:

	LENGTH OF CIRCUIT.	ERROR PER MILE.
† 1	3 miles	0.0327 feet.
† 2	5 "	0.0162 "
3	6 "	0.0112 "
4	16 "	0.0033 "
5	18 "	0.0009 "
‡ 6	39 "	0.0005 "

Now all this would indicate that the error is proportional to *even less* than $\surd$ distance.

Will some reader give the correct theory?

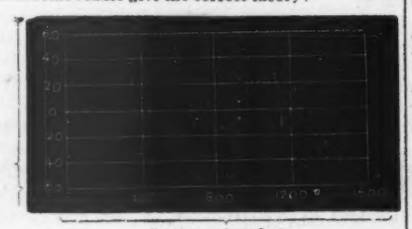


Diagram showing variation in apparent errors due to observation. [Probable error = ⅓ observed variation].

Vertical scale = difference between calculated heights of instrument.

Horizontal scale = distance leveled.

KAPPA.

* See J. B. Johnson in *Van Nost. Eng. Mag.* for October, 1883.

† Independent circuits.

‡ Ten miles of this line run to hundredths only.

PROBLEMS IN COMPOUND CURVES.

Special Correspondence Engineering News.

PHILADELPHIA, Feb. 26, 1884.

EDITOR ENGINEERING NEWS:—As at present stated, the "Problem in Compound Curves," in your last issue, is "indeterminate," as the mathmeticians say; that is, an infinite number of answers can be given, and another condition is required to determine a particular solution. If any point on the tangent is taken as a new P. C., a curve can be run in so as to be tangent to the second curve. If we introduce as the necessary condition that the P. C. C. for the second curve be taken at any convenient place whose distance from station 407 in feet is called x; the distance to go back from the first P. C. on the first tangent will be

$$\frac{\left(1333.29+1146\tan.\frac{x}{40}\right)\left(\sin.\,38°\,48'-\sin.\frac{x}{20}\right)}{\sin.\left(38°\,48'+\frac{x}{20}\right)}+1146\tan.\frac{x}{40}-672.62$$

and the radius of the new curve will be:

$$\frac{1333.29\sin.\,38°\,48'+1146\tan.\frac{x}{40}\,(1+\sin.\,38°\,48')}{1-\text{cur.}\left(38°\,48'+\frac{x}{20}\right)}$$

If x=374 (as it seems to scale from the cut) the distance to go back on the tangent is 68.6 and the radius of the new curve is 2473 feet, or a 2° 19' curve. In the formulas, 1333.29 is the tangent distance of the first curve plus the intermediate tangent; 1146 is the radius of a 5 degree curve; 672.62 is the tangent distance of the first curve; and 38° 48' is the total angle of the first curve.

C.

PHILADELPHIA, Feb. 26 1884.

EDITOR ENGINEERING NEWS.—In answer to the question of "A Subscriber," in your number of the 23d, I am of the opinion that the system of curves and tangents cannot be explained by a compound or a simple *circular* curve, having the same length as the former combination.

The reason of it is, that though we can construct an infinite number of curves tangent to a given line and corresponding with another curve, or tangent to two lines, there is in either case but one curve possible that passes through a given point in either line or curve. It is, however, possible to construct an infinite number of combinations of tangents in curves between the tangent points of our constructed curve, so that it would be a mere chance if the constructed *circular* curve was equal in length to the existing combination.

"Subscriber" makes the mistake to put too many conditions; it is the same case as if we would construct a circular passing through four points chosen at random.

Yours respectfully,

E. THIANGE, C. E.

"HIRE 'EM AT THE MARKET PRICE."

Special Correspondence Engineering News.

NEW YORK, Feb. 25, 1884.

EDITOR ENGINEERING NEWS.—This contemptuous instruction was, some years ago, attributed to Mr. Robert M. Galloway, the president of the notorious Manhattan Elevated Railroad Company, in reference to hiring some of that class of useful servants known as *Civil Engineers*, but so trite is the sentiment therein expressed and so becoming is it in the mouth of any of the swarthy sons of Israel, of the purlieus of Chatham street, that it is unfair to tax the above named gentleman with its origin.

What is an Engineer and what is his market price?

The theme is full of suggestions and perhaps some of your readers can, if they will, expound our text to its full proportions; and if this communication should provoke a discussion in your columns, it may lead to the development of a mere vocation to the dignity of a learned profession.

This can only be accomplished when the purity o commercial element is almost wholly eliminated from consideration.

What is an engineer? How many kinds of engineers are there?

What are the plans and specifications for the manufacture of an engineer?

What is he worth at his "market price?"

If a marketable article how and by what standard may his value be established?

Mr. Galloway is not singular in his views, since we have heard the same sentiment expressed by eminent "professional" lips to their own discredit.

"Engineering" can only make empty claims to a professional importance until its practitioners assert its professional dignity like those of law, medicine and theology.

Those who know will concede that the qualifications requisite for an engineer are not inferior to those demanded in the practice of any of the "learned professions."

A proper recognition can only be reached by the insistance of a professional standard of quality and "market price."

Engineers, as a body, have been content to accept (and be thankful for it) the position assigned them by the general public; "a little better than the village blacksmith and not quite so good as the village carpenter." In other words the "Engineer" is only recognized as an ill-defined and ill-understood "What is it." In comparison with doctor, lawyer, or priest, the engineer has no standing. It is unpleasant to imply reflections upon the esteemed and codeless vocation, that ought to rank as a learned profession, but in endeavor to bring our "tangents to an intersection," we will ask some of the amiable, but above all meek, gentlemen that periodically hold solemn conclave as a would-be "professional" society of engineers: what are you worth collectively and individually? Can you be bought or sold "at the market price," by the pound or by the ton, by cubic foot or by cubic yard, by the water-inch or by the gas metre.

Latest market quotations would indicate that assistant engineers could be supplied for the asking, and that the value of a chief engineer is somewhat less than that of a Kentucky mule.

Much may be accomplished when the "Societies" give up twaddling and take serious action.

Not very long ago the village barber was also the village surgeon; and the chaplain made a good match when he married my lord's "cast-off."

"Patience and shuffle the cards."

Engineering may yet rank as a learned profession, free from the stain of a "market price," but its energy must come from within.

$$\frac{dy}{dx}$$

ADJUSTMENT OF GRADES TO CURVES.

FOREST SOUTHERN RAILWAY, TIONESTA, PA. March 3, 1884.

Special Correspondence Engineering News.

EDITOR ENGINEERING NEWS.—Having been asked by several of my engineer friends to publish a statement of the results of a series of experiments on adjustments of grades to curves, or the equation of curvature. I have prepared the following, which, if up to your standard, please insert.

The road on which the following results were attained, is a narrow gauge (3') with maximum grade

2.2 feet per station—equated—on the mountain division and grade fitted to surface along the valley which it follows for eight miles.

A "scale drawhead," was made for the purpose and made to show the additional strain in pounds required to draw it around *level* curves of different designs of curvature up to 21°. I found in seven out of nine curves of 1° that the strain was the same and varied but slightly in the other two. Reducing this to strain or resistance in terms of grades, I found it equal to 0.038 feet per station of 100 feet. It did not increase directly in proportion to the degree of curvature, but by combining the results they seem to nearly fulfill the following law, which was so *very* near that I adopted it deeming that irregularities in the curves and unevenness in the track accounted for the discrepancies.

Let A = the equation for a 1° curve (0.038).

Let W = the equation for a 21° curve (0.0581) in terms of grade.

Let x = the increment to a 2° curve.

The results obtained were expressed for each curve by the following formula.

$$A + (1)^2 x + (2)^2 x + (3)^2 x \ldots\ldots\ldots\ldots + (20)^2 x = W \text{ or}$$
$$[x + 4x + 9x + 16x \ldots\ldots \ldots\ldots + 400x = 0.0201$$
(2°) (3°) (4°) (5°) (21°) etc.

whence $x = 0.000007 \times$ feet in terms of grade.

Following is the result of my observations tabulated, which were used on the mountain division and proved highly satisfactory and equal on all courses introduced on that division. The same drawhead was used, and varied but little on any of the curves, in fact, remained practically stationary, showing but a difference of 7.72 pounds between extrems. Rate or speed 5 miles per hour. The greater the velocity the greater the change in the indicator caused no doubt by the swaying motion of the train. I give my observations for what they are worth, and would like to hear from others on the subject.

No. of term or Degree of Curve.	A. Constant to 1° Curve and all Curves.	Increment to be added to const. for curves from 1° to 20°.	Increment and const. per degree up to 21 degrees.	Degree of Curve.	Total Equation in feet per sta. —if ascending, +if descending.
1	0.038	0.000000	0.038	1	0.038°°°
2	"	0.000007	0.038007	2	0.076014
3	"	0.000035	0.038035	3	0.114105
4	"	0.000098	0.038098	4	0.152392
5	"	0.00021°	0.03821°	5	0.19105°
6	"	0.000385	0.038385	6	0.23041°
7	"	0.000537	0.038537	7	0.270159
8	"	0.00098°	0.03898°	8	0.31181°
9	"	0.001428	0.039428	9	0.354852
10	"	0.001995	0.039995	10	0.39995°
11	"	0.002695	0.040695	11	0.447615
12	"	0.003542	0.041542	12	0.498504
13	"	0.00455°	0.04255°	13	0.55315°
14	"	0.005733	0.043733	14	0.612262
15	"	0.007105	0.045105	15	0.676575
16	"	0.008680	0.04668°	16	0.74688°
17	"	0.010472	0.048472	17	0.824024
18	"	0.012495	0.050495	18	0.908910
19	"	0.014763	0.052763	19	0.002497
20	"	0.01729°	0.055290	20	0.1053°°
21	"	0.020090	0.05809°	21	0.219880

The table may be too lengthy, and if it is, give the last column only.

F. F. WHITTEKIN,
Chief Engineer.

RAILWAY BUILDING FIFTY YEARS AGO.

Special Correspondence Engineering News.

NEW HAVEN, CONN., Feb. 28, 1884.

EDITOR ENGINEERING NEWS.—Thinking that some notes of the manner of railway building fifty years ago may be of interest, I have made the following extracts from the Engineers report to the President and Directors of the Ithaca and Owego Railroad, from a printed copy in my possession:

This road was built in 1832-4 and now forms the Cayuga Division of the Delaware, Lackawanna & Western Railroad.

A M. S. note at the end of the report is as follows: "The building of this road was begun in 1832 and opened in the spring of 1834. In 1839 parts of the road were realized and locomotive power employed, and in 1847 they *returned to the use of horse-power.*"

The italics above are mine. What the difficulty with the locomotive power was I am unable to state.

The Chief Engineer was Mr. John Randel, Jun. The surveys were of the most elaborate description, "A base line was surveyed and levelled from Ithica to Owego * * * lines were then surveyed and levelled across the whole bed of the valley, at stations generally about 800 feet apart on this base line, and at right angle thereto; and in cases where it was judged needful for the purpose of obtaining a better location for the road these surveys were further extended to the foot of each hill."

After a very minute description of the location adopted the author continues:

"From these reconnoissances, surveys, and examinations it became manifest that the maps before mentioned (which comprised the elevations and improvements of the whole district of country deemed at all eligible for the location of your railroad) had enabled me, *at a very small cost*, to select for this road, the *most gentle grades*, * * * *curves of the greatest radius*, * * * * *straight lines of the greatest length*, and a *route* the most *eligible* and *least costly* that the country would afford; and that, too, with *more certainty* of being the *best*, and at *much less cost* than it could have been done *without* these preliminary surveys and maps."

During the construction some difficulty with contractors was evidently experienced, showing that human nature in "the good old times" was very much what it is in these degenerated days. Engineers of to-day will probably appreciate the following:

"Some of the contractors have made satifactory progress in their work * * * but the Directors have been peculiarly unfortunate in the selection of others, who have proved delinquent by neglecting their work; some of them wilfully, and others negligently, destroying the line and level pegs and stakes placed for their guidance in grading their sections. The pegs and stakes destroyed upon the whole line of road is, it is believed, unprecedented."

Possibly a little judicious curtailment of the monthly estimates, or a bill for extra engineering work might have had a beneficial effect in these cases. The author presented five different plans, with estimates of the cost of each, for laying the "rail-way," a comparison of which with our modern standards is of interest. Omitting the detailed estimates they are as follows:

"PLAN No. 1.—By this plan the cross sleepers and longitudinal string pieces (for the reception of the flat iron rails) are to be made of *wood;* the sleepers are to be placed in the usual manner and *four* feet apart from the centre to centre; longitudinal sills are *not* to be placed under the cross sleepers, (a rail-way made upon this plan will require frequent repairs). Estimate of cost of *one mile* of rail-way by Plan No. 1, $3,453.76."

"PLAN No. 2.—By this Plan the longitudinal sills, cross sleepers, and string pieces, are to be made of *wood*, and the sleepers are to be placed *three* feet apart, from centre to centre, between the longitudinal sills and string pieces. The string pieces are to be fastened to the cross sleepers by means of wooden keys or wedges, and the cross sleepers are to be fastened to the longitudinal sills by 6 inch iron spikes (a railway made upon this Plan will require but few repairs for the first eight years). Estimated cost of one mile of rail-way by Plan No. 2, $1,528.36."

"PLAN No. 3.—By this Plan string pieces of white oak are to be laid on *stone block* of the usual dimensions (18 to 24 inches square at top, and from 9 to 12 in depth) and fastened thereto by means of cast-iron knees; the blocks to be placed 3 feet apart from centre to centre; the rail-way is to be prevented from spreading by placing cross sleepers or ties of wood under the rails, 12 feet apart. Estimated cost of one mile of rail-way by Plan No. 3, $5,758.38½."

PLAN No. 4.—By this Plan the cross sleepers (or connecting pieces and posts) and the longitudinal sills or rails, are to be of *stone*. As a present *substitute* for the improved iron edge rails submitted by the subscriber to the Board of Directors: flat iron bars, of the usual, or improved form and dimensions, are, *by this Plan*, to be placed *along the centre* of the stone rail, having a lath or piece of wood (oak or locust) from 1½ to 2½ inches in thickness, placed between the iron and the stone, for the purpose of raising the rail a sufficient height above the stone, to allow free passage to the flangs of the cars, without incurring the additional cost of dressing the stone rails, or cutting a grove for that purpose. This lath will give elasticity to the rail-way and save it from abrasion; the rail or spike that fastens the metal rail to the stone rail or sill, is to pass through this lath. Estimated cost of one mile of rail-way by Plan No. 4, $5,785.04."

"PLAN No. 5.—By this Plan *stone rails* from 12 to 15 inches in width, and from 7 to 9 inches in depth, are to be bedded upon a continuous line of *stone wall*, or foundation, from 14 to 16 or 20 inches in height, and from 20 to 24 inches in breadth at the base, (the ends of the stone rails are to be securely bedded upon connecting stones). This wall is to be built in the form of a *frustrum of a prism*, upon a foundation of well consolidated gravel or sand, from 6 to 16 inches in depth, laid in a trench excavated for that purpose, to a depth of from 20 to 30 inches below the level of the roadbed. The whole of the stone work is to be laid in mortar or grouted with hydraulic cement grouting. Culverts or openings are to be made, or left at suitable distances in, and through the walls, so as to afford free passage for the water from the roadbed to the side drains. The metal rail is to be placed along the *centre* of the stone rail in the manner described in Plan No. 4.

The above mentioned form for the wall (the frustrum of a prism) as well as its foundations (well consolidated gravel or sand) I would respectfully recommend as *the best* to resist the action of the frost upon the Railway. Estimated cost of one mile of Railway by Plan No. 5, $6764.80."

The following appears in a foot note: "I have found this form (frustrum or prism) to be the best, by from 18 to 20 years experience of the effects of the frost upon that portion of the 1600 or 1700 marble monumental stones (that had this shape and foundation) that were placed under my direction, at the corners of the streets and avenues in the city of New York (as early as between the years of 1808 and 1818) by directions of the Commissioners of Streets and Roads (appointed by the Legislature of the State of New York) and by the corporation of that city."

In conclusion, the "combination of Plan No. 2 * * * and Plan No. 5, and occasionally of No. 4 * * * * is respectfully recommended to the Board of Directors for their adoption, by Gentlemen, very respectfully.

Your obedient servant,
JOHN RANDEL, Jun."

When one thinks of the effect of a modern engine passing over such a "Railway" as above described, even at a low rate of speed, if, in fact, it would be carried at all, the wonderful advance made in railway construction and machinery in the half century just past, is brought more clearly to ones mind, and the question naturally arises, What will the next fifty years develop?

Very respectfully,
A. BRYSON, C. E.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E. : M. INST. C. E.

(*Continued from page* 116)

DCI. HALLOWELL, ME.

Hallowell, Maine, in lat. 44° 15′ N. long. 69° 50′ W. is on the Kennebeck River at the head of navigation, 38 miles from its mouth. It was formerly largely interested in shipbuilding, but now principally in the export of granite and ice. Water-Works were built by a private company in 1876, taking the supply from springs, the water from which is collected in three reservoirs, one 80 feet square and 9 feet deep; at 100 feet above the city. The others are 65 feet above the city, one of them being 20 ft. square by 9 ft. deep, constructed of granite and the other 80 by 90 ft. which is to be paved during the coming summer. Distribution is by 2½ miles of wrought-iron pipe of 2½ and ¾-inch diameter The first pipe used was rubber coated, which stood well in some places and corroded badly in others. Galvanized pipe is now used for mains and services. The number of taps is not given, nor the consumption.

The population in 1880 was 3,154.

The works have cost $12,000. No further financial statements are furnished.

J. R. Bodwell is President, and Orlando Currier, Secretary and Treasurer.

DCII. ST. JOHNSVILLE, N. Y.

St. Johnsville, New York, in lat. 43° 0′ 2″ N. long. 74° 40′ 46″ W., is on a plateau with the Mohawk flats and river on the south and elevated land on the North. Settled in 1818, it was incorporated a village in 1837. Water-Works were built by the village in 1879, taking the supply from a spring about 100 feet above the level of the town on the upland. Distribution is by 4 miles of 2-inch wrought-iron pipe, with 100 taps. There is no fire service. Service pipe is of wrought-iron.

The population in 1880 was 1072. The consumption is not known.

The works cost $9,200. The bonded debt is $3,500 at 6 per cent. interest. The expenses in 1883 were $250 and the receipts $500. The works are under the direction of the Trustees of the village. W. E. Churchill is the Secretary.

DCIII. APPLETON, WIS.

Appleton, Wisconsin, in lat. 44° 10′ N. long. 88° 30′ W. is on both sides of the Fox River. The river, which has a fall of 40 feet within the city limits, affording good water power; flows through a valley about half a mile wide and 50 to 65 feet deep, with steep sides intersected by deep gullies.

Water-works were built in 1883 by a private company after plans of E. C. Cooke, C. E., taking the supply from a bored well 430 feet deep sunk in the Potsdam sandstone and yielding 1,000,000 gallons a day. A second well is now in course of construction. The water is allowed to settle before being used, as it holds

a certain amount of fine sand in suspension, as it flows from the well. The supply is pumped directly into the mains by two pairs of pumps of 12 in. diameter and 24 in. stroke, driven by Victor turbine water wheels supplied from the pool above the stone dam 700 feet long and 10 feet high, built across the river by the U. S. Government. The capacity of the pumps is 3,000,000 gallons per day. There is also a direct acting steam pump of 24 in. steam and 12 in. water cylinder, of 24 in. stroke, of 1,000,000 gallons daily capacity. The pumps were furnished by the Deane Steam Pump Co., Holyoke, Mass. The highest ground in the city is 50 feet above the pumps. The ordinary pressure maintained at the pumps is 80 lbs., and the fire pressure 100 to 140 lbs. Distribution is by 12 miles of cast-iron pipe of 16 to 4 inches diameter, with 80 fire hydrants, 65 gates and 75 taps. There is one meter in use. The city pays $75 per year for each fire hydrant. Service pipes are of wrought-iron.

The population in 1880 was 8,005 and is now said to be 12,000. The daily consumption is unknown. The capital stock of the company is $100,000. No further financial statements are furnished. S. L. Wiley is President of the company, J. M. Payne, Secretary and E. C. Cooke the superintendent.

DCIV.—STRATFORD, ONT.

Stratford, Ontario, in lat. 42° 45 N. long 81° W. is on irregular ground on the River Avon. Settled in 1834 it was incorporated a town in 1858.

Water-works were built by a private company in 1883 after plans of John M. Moore, C. E., taking the supply from the River Avon above the town. There is a stone dam across the river at this point. Above the dam 20 channels or ditches were excavated in the bed of the stream, 10 to 12 feet deep and filled with cearse gravel. These lead into a covered basin of oak plank 20 by 10 feet, and from this a 12 inch pipe leads to a well from which the water is pumped directly into the mains by a Worthington steam pump of 1,250,000 gallons daily capacity. The ordinary pressure maintained is 60 lbs. and the fire pressure 100 lbs. Distribution is by 2 miles of cast-iron pipe of 12 to 4 inch, diameter, with 13 fire hydrants. The number of taps is not given, nor the consumption, the works having begun operation only in October 1883. The town pays $125 per year for each hydrant. Service pipes are of lead.

The population is 8,560. The works have cost $37,500. The present expenses are at the rate of $3,000 per year, and the income at the rate of $5,000. James P. Woods is President, D. T. Bailey, Secretary and Treasurer, and Thomas Clark the Manager.

WATER.

Marblehead, Mass., will increase its water supply.

A proposition is up before the city council of Pueblo, Col., to deny water for irrigation to parties who do not take it for domestic purposes as well.

The artesian well at Russel, Kan., has been bored down 965 feet, but so far flowing water has not been found.

Taunton, Mass., wants to issue additional water bonds to the amount of $200,000, making its total water debt $550,000. No opposition.

By a decided vote the Massachusetts House rejected the bill to provide that there should be throughout the State a standard uniform fire-hose coupling.

There is a lively contest in progress at Albany, N. Y. concerning a proposed increase of water supply.

Saratoga, Springs, N. Y. is asking for an appropriation of $40,000 for additional water supply.

Brockton, Mass. has appropriated $50,000 for extension of water mains.

Sedalia, Mo. is discussing water-works, and Boone, Iowa has let the contract for water-works to Geo. C. Morgan & Co., of Chicago.

Bismarck has let the contract for water-works to Philadelphia parties. Reservoir system and Holly engines.

A bill to incorporate the Virginia Aqueduct Company has been introduced into the Virginia Legislature by Mr. Callahan.

Wyandotte, Kan., is enlarging its water-works; large reservoirs are to be built.

A Mr. Hunter, of Shane's Crossing, Ohio, advises the digging of an enormous ditch, from the Ohio river at Wellsville to Lake Erie, and thus stop further floods. He asserts that at flood mark the Ohio is 100 ft. higher at this point than the Lake. There are some ugly hills in the way, but for "further views," as he says, apply to him.

The Committee on Water Supply, of the Massachusetts Legislature, has reported a bill providing that cities, towns, fire districts, water and aqueduct companies having water to sell may dispose of it to other cities, towns, fire districts, and individuals. A measure of similar character was vetoed last year by Gov. Butler.

The Kansas City Water Company has ordered of the Holly Manufacturing Company, a Gaskill compound condensing pumping engine of 3,000,000 gallons daily against 300 feet head capacity, to be shipped from the factory May 1st, and guaranteed to give 85,000,000 foot pounds duty.

The New Pumping Engine of the Columbus, Ohio, Water-Works.—The *Dispatch*, of Columbus, Ohio, reports the late very satisfactory test of the new Holly-Gaskill pumping engine at that place. The contract called for a pumping capacity of 10,000,000 gallons in 24 hours, with a piston speed of 125 feet per minute, to give a domestic pressure of 60 lbs., and a fire pressure of 120 lbs. per sq. inch, and to develop a duty of 85,000,000, with a consumption of 100 lbs. of coal.

The duty test, commenced on February 23, was conducted by Prof. Mendenhall, of the Ohio State University, Columbus, Ohio, and the result of the first six hours run is given as follows:

"Number of revolutions of the fly-wheel, 5,565; average number of revolutions of the fly-wheel per minute, 15.5; total amount of water pumped, 2,169,234 gallons, at which rate the amount in 24 hours would be 8,676,936 gallons. Assumed height to which water was pumped (reduced from pressure), 176.9 feet; total foot-pounds of work in six hours, 3,197,515,000; water supplied to boilers, 28,969 pounds; duty per 100 pounds of coal (on a basis of 10 pounds of water to 1 pound of coal), 110,340,000; duty on 100 pounds of coal on same bases required in contract, 85,000,000; excess of performance over specifications, 30 per cent. Including whole period of seven and one-half hours and ignoring the high pressure against which the engine pumped for about 15 minutes, the result was: Duty for 100 pounds of coal (on same basis as above), 112,860,000; duty per 100 pounds of coal including the high pressure during fire test, 114,180,000."

The superintendent of the water-works, Mr. Wesley Royce, in allowing 40,000,000 duty to the old pumping engine, figures a saving in the new pump of 4.95 pounds of coal per horse-power.

Concrete Water Pipe.—In a late number of the *Annales des Ponts et Chaussees*, a cheap method of making water pipes of small diameter is described. The pipes were formed of concrete in the trench itself. The mould into which the concrete was stamped in was of sheet-iron, and had a length of about two yards. The several pipes were not specially joined to each other, the joints being simply set with mortar. The concrete consisted of three parts of slow setting cement and three parts of river sand, mixed with five parts of limestone *debris*. The inner diameter of the pipes was 9 in.; their thickness, 3 in. The average fall is given at 1:500; the lowest speed of the current at 1 ft. 9 in. per second. To facilitate the cleaning of the pipes, manholes are constructed every 100 yards or so, the sides of which are also made of concrete. The trenches are about 5 ft. deep. The work was done by four men, who laid down nearly 200 ft. of pipes in a working day; the cost was about 3s. 9d. per yard run. It is claimed as an advantage for the new method, that the pipes adhere closely to the inevitable inequalities of the trench, and thus lie firmly on the ground. The works were carried out by M. Thanneur, for the water mains of the town of Coulommiers. It may here also be mentioned that in the course of the Canal du Verdon, which supplies the town of Aix-en-Province and the neighborhood with water, several mains were carried in a similar manner. But the concrete pipes which are submitted to great pressure have not proved effective. The method, consequently, is only suitable for pipes in which there is no pressure, or only a very trifling one.

The Pond Engineering Company, St. Louis, have opened the water-works building, season of 1884, by closing contract with the city of Greenville, Ill., for a set of pumping machinery for their water-works, consisting of two three-quarter-million Blake pumping engines, with boilers, etc., complete. Work will be commenced at once.

The Philadelphia Water Department was authorized, on March 4, to lay a 16-inch main to cost $33,000; also to advertise for proposals to build a store house at the Spring Garden Works, the cost not to exceed $2500.

A firm of Philadelphia paper manufacturers have been paying a water rent of $800 for years past; a late official test by meter proved that they annually consumed $2600 of water.

The Evansville, Ind., Pump and Pipe Co. was incorporated this week, capital stock, $50,000.

Bills passed the Mass. Legislature on Feb. 28, authorizing the town of Lorain to issue bonds for the construction of water-works; and authorizing all village corporations to appoint sewer commissioners; also a bill to authorize the town of Clinton to issue additional water bonds, and to furnish water to the inhabitants of Lancaster.

Pittsburg, Pa., wants more fire plugs on the south side, hose must now be sometimes carried 1600 ft.; Controller Morrow thinks the Monongahela Water Co. contracts to supply a sufficient number, and he is going to look the matter up.

The contract to build water-works at Cortland, N. Y., has been awarded to Hinds, Moffett & Co., of Watertown, N. Y. The water is taken from a spring and pumped by steam through 1600 ft. of 10 in. main into an iron water tower 40 ft. high and 40 ft. in diameter, located on a hill 130 ft. above the town. A 10 in. main from the tower supplies the consumers by gravity. Between 5 and 6 miles of mains and 50 hydrants will be required for the supply. The Cortland works are to be completed by July 1, 1884.

At Fulton, N. Y., the water is to be taken from the Oswego river, and pumped by water through about 4 miles of mains to an iron water tower, 15 ft. in diameter and 40 ft. high, located 100 ft. above the river. This work is to be finished by Oct. 1, 1884.

The utilization of the water of the Merrimac, between Haverhill, Mass., and Lawrence, for mechanical and manufacturing purposes, is becoming a topic of considerable interest. The largest amount of power is concentrated at Mitchell's Falls, some 2 miles above the city proper. There is a fall of 9 feet in the river at this point, which is estimated to be equal to a 3000 horse power. The river is navigable from the ocean to this point, and would afford water transit for freight each way.

NEWS OF THE WEEK.

Contracting Miscellany.

President Baldwin says there is no foundation for the rumor that the Louisville & Nashville Railroad will furnish money for the completion of the Charleston, Cumberland Gap & Chicago Air Line.

The Asylum Commission has accepted the plans of Architect Ketcham for the buildings at Evansville and Richmond, Ind., and they are to be ready for the contractors by March 10. Bids for the work will be opened the 8th of April.

Piqua, Feb. 26.—The Board of Education of this city has closed contracts for the erection of a fine new high school building, to cost $50,000. It will be erected on the site of the old one, which is to be torn down immediately.

Stone Contract Awarded.—The firm of Peter G. Straub & Co., of Buffalo, N. Y., has been awarded the contract for furnishing Ohio buff sandstone for the new public buildings at Peoria, Ills., at its bid of $37,800.

This city will build at Nos. 422 to 428 West 28th street, an additional Grammar School No. 33, which will cost $60,000. It will be four stories high, will cover an area of 94½ by 60 feet, and will have a brick front. D. J. Stagg is the architect.

Assemblyman Roosevelt is having a handsome residence built at Cove Neck, Oyster Bay, at a cost of $25,000. James K. Gracie, of New York, is also having a handsome residence erected at the same place at a cost of $20,000.

The ease and rapidity with which buildings can be put up in the winter season has been shown in two structures nearly opposite each other; one at the southeast corner of Union Square and the other at 23d street and Fifth avenue. The former was heightened by two or three stories, the materials going up in a warm elevator, and the latter has been built in midwinter of an unusually severe year, by inclosing and warming the masonry.

The floods in the West are going to be a disadvantage to the growth of some towns lying down upon the rivers, whose active inhabitants have now been tortured for two winters by high water and are moving back into the interior on the railroads. Some of the Cincinnati manufacturers are going back to Hamilton, and the people about Marietta, Parkersburg and adjoining towns are a good deal tempted to pull up their stakes.

Paper Corporations.—Ottawa, Mar. 1.—The proprietors of the Ottawa, Waddington & New York Railway are hanging around the lobbies of Parliament endeavoring to get the time for the completion of that road extended for a few years. Attention was called this morning in the Railway Committee to the great number of railway charters which are being granted, thus creating paper corporations whose only object is to get a charter with a commercial value to it and sell it for what it will bring.

THE Loomis Building Company at Chicago will erect a building near the new Board of Trade for office use; capital, $400,000; incorporators John M. Loomis, John McLaren, and George W. Keehn.

MR. GEORGE GARFIELD, a cousin of President Garfield, has gone to Pensacola, Fla., to erect a large Government building. He has just finished a Government building at Paducah, Ky., and completed it within the appropriation, without entailing upon the Government a long bill of extra work. He was informed at the time of settlement with the Government that he never need be without a Government contract while he conducts his work so honestly.

AT a meeting of the Committee of Buildings and Charities of the Cook Co., Ills., County Board at Chicago, it was decided to advise the Board to advertise for plans for the new insane asylum, of which five of the best plans should be selected and $200 paid to each architect therefore. From this number, again, the best and most appropriate design should be adopted. The estimated cost of the new building will be between one-half and three-quarters of a million dollars. The contract for the necessary plumbing for the present Insane Asylum Building was awarded to J. C. McGraw.

BIDS were opened on March 4, by the Public Buildings Commission for general roofing and gutter work on the City Hall in Philadelphia, as follows:

Haugh, Ketcham & Co., of Indianapolis: Item 1, to furnish and set in place, complete, all the wrought, rolled and cast-iron required for the North centre pavillion and wings, $83,343.06; item 2 girders and beams for two floors—clock tower, $3,388.46; item 3, ceiling in Southwest corner, $6,097.13; item 4, iron gutters in centre pavilions in court yard, $1,710; item 5, gutters on main cornice of East and West centre pavilions, $2,070; item 6, all other gutters not included, eight cents per pound.

Phœnix Iron Company: Item 1, $79,975; item 2, $3,750; item 3, $3,775; item 4, $1,335; item 5, $1,750; item 6, seven cents per pound.

Jones & Benner: Item 1, $181,943; item 2, $2,985; item 3, $4,975; item 4, $1,350; item 5, $2,750; item 6, six and one-half cents per pound.

For iron clamps and tin, L. Sipes & Co. were the only bidders, at $4.85 per pound.

For bricks, Murrell Dobbins bid to furnish one or two million at $7.93 per thousand.

John R. Huhn, hand-made brick, at $8 per thousand.

The Excelsior Brick and Stone Company at $7.73 per thousand.

Bids for furnishing granite were made as follows: Charles A. Barker; Item 1, granite coping for the areas of the East and West fronts, $4,590; item 2 sills and platforms for East centre pavilion, $442; item 3, the same around the Northeast and Northwestern corner pavilions, $4,060; item 4, bearing blocks for trusses, $605.

The Mount Waldo Granite Works: Item 1, $3,665; item 2, $391.32; item 3, $6,291.84; item 4, $288.70,

Cape Ann Granite Company: Item 1, $3,190.08; item 2, $534.50; item 3, $6,824.89; item 4, $231.

Wood & Tracy: Item 1, $5,584; item 2, $874; item 3, $6,642,49; item 4, $600.

For brick work the bid of Alexander Armstrong was $14 for enameled bricks in brick arches in first story and basement; $3.69 for second and third stories; $5.70 for roof. Laying hard brick, $4.24 per thousand; pressed brick, $10.50.

Miles King: $14 for enameled brick, and hard brick, $4.20 for the arches in basement and first story; $4.50 in first story; $4.75 in second: $5.20 in third; $5.25 in fourth; and $4.25 on roof. Laying brick, $3.48, and pressed brick, $12.

For cement—J. Rex Allen proposed to supply with different brands in barrels of 300 and 400 pounds, at pri es ranging from $1.32 to $3.23, and Edward A. Smith & Son, at prices from $1.30 to $3.25.

Dennis Conway was the only bidder to furnish set in place and complete all slating required, his figure being $13,920.

E. W. Gaskill & Sons offered different quantities of lumber at varying prices, and were the only bidders.

The bidders for supplying coal were Joseph McDonald—Broken and nut coal, either Lehigh or Schuylkill, at $5.25 per ton of 2240 pounds, and stove at $5.50.

Patrick & Lipsatt—Lehigh, egg and broken, $5.09; stove, $5.45; nut, $5.09.

George B. Newton & Co.—Ash egg, $4.85; stove, $5.00; and nut, $4.90; Lehigh egg, $4.85; stove, $5.00; nut, $4.90, and broken, $4.85.

The several proposals were referred to the president, architect and superintendent, to be scheduled, and will be considered at a special meeting.

The trustees of Dartmouth College, Hanover, N. H., have voted to erect a library building at a cost of $50,000.

ARMOUR, KENT & BENTLEY, of Chicago, have taken out a permit to build a twelve-story office building 174x172 feet, at Van Buren street and Pacific avenue to cost $1,000,000 unfurnished. This will be the most expensive office building in Chicago, the roof will be 176 feet above the sidewalk.

THE contract with Architect Richardson of Boston, Mass., for the New Pittsburg, Pa., Court House, is completed. As soon as the contract is approved arrangements will be made for clearing the site.

APRIL 1, 1884 will probably end the existence of the St. Nicholas Hotel in New York. A six-story store building is to take its place, to cost about $350,000. The hotel was opened in 1851, the property is valued at $800,000 to $1,000,000.

THE contract for cleaning the lower end of New York City was awarded on March 3, to J. S. Brown for $127,500; Mr. Brown was also the lowest bidder for the uptown district at $228-000, but his bid being informal will probably be rejected, and the contract be given to Hayward & Duffy for $229,000.

ATLANTA, Ga., received bids for street paving last week. Twenty miles of brick sidewalk were awarded to G. S. Lockett & Co., for 45 cents per square yard; belgian and rubble paving to Venable & Co., for $2.09 and $1.09; and curbing to J. A. Alexander at 37½ cents per lineal foot. A bid from the Warren Sharp Asphalt Co., of Philadelphia was not received as the Councils had not asked for work of that character, belgian or rubble paving being preferred.

THE contract has been let for furnishing the monument in memory of the victims of the Newhall House disaster (according to the design of Henry O. Avery, the New York architect,) to Brown, McAllister & Co., of New York. The monument will cost about $6.000 exclusive of the foundation. By the terms of the contract it is to be finished next July, when it will be set in place. The working plans have already been sent to the New York sculptor, whose bid was the lowest. The design of the monument, while not very elaborate, is quite handsome. It will be an elaborate shaft of Maine granite, 30 feet in height, octagonal in shape, and inscribed, "To the memory of those who perished by the burning of the Newhall House, Jan. 10, 1883." The names of the victims will be cut in the monument near the base. It will be placed over the grave of 24 unidentified bodies of the hundred victims.

Gas and Electricity.

ORANGE, N. J., has a pledged capital of $40,-000 for the formation of a company to provide the city with electric lights.

The promoters of the enterprise are Daniel A. Heald, H. B. Auchincloss, Henry C. Pedder, William Barr, Samuel Lord, Jr., Samuel Colgate, George Lindsley, Everett Frazier, and David Bingham.

THE City Council of Fort Wayne, Ind., contracted on Feb. 26 with the Fort Wayne Jenny Electric Light and Power Company to illuminate the city one year, beginning w th July 1st. There are to be nine towers, with five lights each, on the outskirts, and sixty additional lights suspended over street crossings.

JUDGE INGRAHAM of the Superior Court has given judgment in the case of the property owners in West 25th street, New York, *vs.* the Brush Electric Light Co. He holds that the company was authorized by the proper authorities to erect poles and wires, and the property owners have no more right to object than if the city did the lighting.

A FRANCHISE has been granted to Reed, Tustin & Co., of Pittsburg, Pa., by the Council of Kansas City, Mo., to organize a natural gas company to supply gas for heating purposes. The capital stock is $200,000. The company are to bore wells, lay pipe, etc., and furnish gas to the consumer at a cost not exceeding $1.50 per 1,000 feet. The firs wall will be located about one mile north of Kansas City, and gas is expected at a depth of 1,800 or 2,000 feet.

Bridges.

PHILADELPHIA Port Wardens have under consideration a new bridge across the Schuylkill River, near its mouth, on application of the East side Schuykill River R. R. Co.

CONTROLLER Brown, of Allegheny, Pa., is receiving proposals for the erection of a new bridge at Herr's Island to replace the one carried away by the late flood. It is thought it will cost $3,000. He is also receiving proposals for 3000 pounds of blue vitriol for the fire department.

THE iron bridge over Bear Grass Creek, on the Cincinnati Short Line, in Louisville, Ky., gave way Feb. 25th. The accident was caused by the giving way of the stone abutment injured by the flood. The bridge was 150 feet long, 60 feet high.

THE contract for the iron bridge which is to connect the Neville Island railroad with the Lake Erie road was awarded to the Penn Bridge works, of Beaverfalls, for the sum of $15,300. The bridge will have three spans of 150 feet each in length. The stone work of the pier was awarded to Lenart, Johnston & Co., of Pittsburg, Pa.

THE SEVERN TUNNEL, ENGLAND.—Notwithstanding the flooding of a portion of the Severn Tunnel in October, the progress of the works in the past half year has been satisfactory. During that period 1200 yards of tunnel have been completed, and 200 yards arched. Out of a total length of about 4½ miles of tunnel, 3700 yards have now been completed, in addition to about 1600 yards arched.

THE Bartholdi Statue Committee, opened six bids on March 4th for building the pedestal. Owing to a misunderstanding about the specifications the bid were all so much in excess of what the committee can afford to pay that they thought it best not to make them public until the bidders have been consulted and given an opportunity to make any modifications they may desire. The contract will not be awarded until some time next week.

Gen. Stone, the chief engineer, said that he expected the work of laying the stone for the pedestal would begin June 1. One month of good weather would suffice to finish the foundation. The expectation was that the pedestal would be done early in the Fall.

Railroads and Canals.

NEW YORK capitalists are surveying an air-line road from Lima to Columbus, O.

THE main office of the Buffalo, New York & Philadelphia Railroad Company has been removed to New York.

A PETITION has been sent to the General Assembly of Rhode Island, for an act to incorporate the Newport Horse Railroad Company.

THE Tehuantepec "Interoceanic Ship Railway Company" is applying to Congress for articles of incorporation.

THE Pennsylvania R. R. Co. is surveying a new line between Landisville and a point north of Marietta. If the grades found, prove satisfactory work will be commenced.

CIVIL engineers will soon begin the survey of the Mount Vernon Railroad. It is expected that the line will start from a point on the Wilton Railroad below the Amherst Station, N. H.

AT its recent meeting the Southern Railroad and Steamship Association changed minimum weight of a car-load from 20,000 to 24,000 pounds.

THE Seney Syndicate has paid the debt on the Brunswick Division of the E. Tenn. Virginia R. R., and now control the line; in the event of failure in this the road would become the property of the Western & Atlantic Company.

AN ordinance was introduced, on February 27, to appropriate $10,000 for an iron viaduct across the railway tracks at St Louis Ave., Kansas City. As the Bridge is expected to cost $25,000, the matter was referred to the committee and the city engineer, to report at the next meeting.

THE Northern Illinois R. R. was incorporated on Feb. 26. It is proposed to build the road from Belvidere, Boone county, in a southerly direction to a point in Hall township, Bureau county, with a branch to Peru and La Sal e. The capital stock is $2,000,000, divided into 20,000 shares. The road will be operated in the interests of the coal-fields of Peru and Hall townships.

OFFICERS of the West Shore Railroad Company say that the prospects are good for a speedy settlement of that Company's financial troubles. The plan for relief provides for the issue of $5,000,000, in two classes of bonds, styled "A" and "B;" Wall Street reports that the Company expect to realize 50 cents on the dollar for the first, and 30 cents on the second class of bonds.

IT is stated that the construction of a tunnel 25,200 feet long through Mount Kelso, which is near Georgetown, Colorado, will make a saving of two hundred miles in transcontinental travel. A company has been at work on the enterprise for four years, and nearly a half mile is completed. The company now proposes to apply to Congress for $50,000 per 1,000 feet as fast as completed.

PITTSBURG rumors of Feb. 28 have it that John W. Garrett and his sons are the purchasers of the Pittsburg & Western railroad, and not the B. & O., as a corporation. The securing of this road apparently means the formation of a short line passage route from Toledo east, as well as from Cleveland.

FOUR Florida railroads have consolidated under the name of "The Florida Railway and Navigation Company," with the following directors: C. R. Cummings, F. W. Peck, of Chicago, W. Bayard Cutting, Thomas C. Platt, L. M. Lawson, E. H. Harriman, E. N. Dickerson and H. L. Horton of New York, Elijah Smith of Boston, D. L. Yulee, C. D. Willard of Washington, D. C., J. M. Schumacher and B. S. Henning of Florida. The system embraces 509 miles of completed railroad, and the construction of extensions north and south will be begun at once.

MR. M. P. HAWKINS, of Minneapolis, says the contract of the Sault Ste Marie Co. with the Northern Pacific R. R. Co. give the right of entry into Minneapolis, on the payment of 6 per cent. interest on half the cost. The first company has also secured 160 acres of ground in the city for round house and shops. Sixty miles of the Sault Ste Marie road have been definitely located and contracts will be let in a few days; it is expected that 100 miles will be finished this year. Work will begin at Turtle Lake, on the N. Wisconsin R. R. and run eastward to the Central Wisconsin, striking it a little south of Phillips. The Minneapolis end must be built in the summer of '85 to meet the conditions of the contracts.

ALBANY, Mar. 1.—The Norwood & Montreal Railroad Company to-day filed articles of incorporation to build a railroad from Norwood, N. Y., to the New York State line in the town of Fort Covington. The road will be about 40 miles long, and will connect at Norwood with the Rome, Watertown and Ogdensburg road. The incorporators include Charles Parsons, William R. Grace, Edwin Parsons, Clarence S. Day, and William Lummis, of New York; James Tillinghast, of Buffalo, and John D. Probst, of Fairview, N. J. The capital of the company is $500,000.

THE annual report of the Penna. R. R. for 1883 shows net earnings on the main line $11,943,432. The net loss on the New Jersey Division was $653,915, which deducted from the net income of the main line leaves a credit balance of $11,289,517 for the year.

The company moved 21,674,160 tons of freight in 1883, exclusive of 1,265,297 tons of fuel etc., for the company's use. The lines west of Pittsburg owned and controlled by the Penna. R. R. show a net profit of $823,896 after deducting rental, interest and liabilities of all kinds. $11,227 should also be deducted from the above amount as the proportion of loss chargeable to the Penna. R. R. on other Western lines in which they have an interest. 67,864 tons of steel rails were laid on the Western lines in 1883, 83,698,162 tons of freight and 48,846,811 passengers carried in the same period.

A CORRESPONDENT of the Pittsburg *Dispatch* makes the following notes concerning the S. Penn'a R. R. This road is to run from Harrisburg to a point not yet made public on the Pittsburg, Mckeesport & Youghiogheny R. R. a distance of 200 miles. The road is divided into six divisions, the line is almost a continuous tangent. The heavy work begins in the second or Tuscarora division and includes 3 tunnels, the Twins and the Tuscarora. The 3d division extends from Hustontown to Bedford, with 2 tunnels, one of these, the Sideling Hill, is 6,700 ft. long. The 4th division commences at Bedford and extends to a point in Somerset county, eight miles east of Somerset, the Allegheny Mt. Tunnel, 5,900 ft. long, is on this division. The 5th division extends from the last terminus to Donegal in Westmorland county, with the Laurel Hill Tunnel, 5,450 ft. long. The work on this division is, on the whole, the heaviest on the line. The 6th and last division runs from Donegal to the connection with the railroad named above.

The above 6 divisions are each divided into 4 subdivisions or "residencies," called A. B. C. D., averaging 7 or 8 miles each. The contracts for all the tunnels have been given out and about 85 miles of the road besides. Among the contractors are Mr. Smith, of Reading, Pa., who will build the Susquehanna bridge at Harrisburg; M'Mahon, Shannon & Green, at the Ray's Hill Tunnel, have a force of 300 to 400 men; O'Brien & Rogers, at the Sideling Hill tunnel, have 400 men at work; Mason & Co., at the Tuscarora Tunnel, have 125 men; Evans & Ackerman, at the Kittaning Tunnel, have 250 to 300 men; Charles McFadden, at the Allegheny Tunnel, has a large force; Patrick Keating, at the Blue Mt. Tunnel, has 200 men; and Patterson & Kuhn have just commenced operations at the Laurel Hill Tunnel.

THE Cleveland, Columbus, Cincinnati and Indianapolis R. R. has borrowed $12,000,000 from the U. S. Trust Co. of New York, by a mortgage on its property.

THE Pullman Palace Car Company will build ten first class passenger coaches, of their latest designs, for the Delaware, Lackawanna, & Western road. They will be ready in May, and cost $6,000 each.

A CORPS of engineers are at Akron, O. waiting for favorable weather to commence the survey of the Baltimore & Ohio extension from Chicago Junction to Akron.

HARRISBURG, Penn. March 4.—A charter was granted to-day to the Reading and Pottsville Railroad Company, the capital of which is $351,350. The road will run between the places named in its title, a distance of 35 miles. Joseph C. Bright, of Pottsville, is President, and the Directors are all from the same place.

ANNAPOLIS, Md., March 4.—The House of Delegates to-day passed a bill accepting the proposition of the Reading Railroad Company in regard to the payment of the indebtedness due to the State for the lease of the Susquehanna and Tidewater Canal, amounting to over $300,000. The bill now goes to the Senate.

THE Government of Gautemala will build a line from the capital to Santa Tomas, to cost $12,000,000. Every male adult has been declared a shareholder. The cost of the shares are $40 each, but those who cannot purchase for cash are required to pay $4 per annum for ten years. An American, General Millen, has secured the contract for some 60 or 70 miles of the line, and has already commenced construction work

WILLIAM L. SCOTT, M. H. Taylor, and A. J. Cassatt are building a line of railroad along the Eastern shore of Chesapeake Bay. The road, which will be called the New York, Philadelphia and Norfolk Railroad, will be ninety miles in length. It will connect the New York, Philadelphia and Roanoke Railroad with the Norfolk and Western and Sea Board and Roanoke roads.

THE N. J. Division of the Penna. Rai road is rapidly laying a fourth track between Philadelphia and New York; 18 miles of third and fourth track were laid in 1883. In the neighborhood of Frankford the heaviest grade on the division is being reduced from 41 to 26 feet per mile. The four track system is now om plete from Menlo Park to Jersey City. A new passenger station is to be built at Trenton at once.

OTTAWA, Ontario, March. 3,—It is understood that a bill will be introduced in Parliament soon authorizing the extension of the Credit Valley Railway from Woodstock to Sarnia in order to connect with the Michigan Railway system. The Credit Valley Road is now virtually owned by the Canadian Pacific Railway Company, and, by such an extension as indicated, the latter company hopes to secure a line to Detroit and Chicago.

THE Broadway Arcade Railway (New York) was again before the Legislature on March 5. In explaining the purposes and necessity for such a road the following statistics of passenger traffic was submitted: When only 4 roads were in existence the annual traffic was 18,400 000: with 12 roads in 1865, the number of passengers carried was 82,000,000, and in 1880, with 22 roads, 211,000,000 passengers were carried.

THE railroad statistics furnished by the tenth census are probably the most complete that have ever been compiled in any country. Accuracy was given precedence to early information, and while the report is thus late in making its appearanse, it cannot fail to have great permanent value. The aggregate assets of the 1,017 railroads in this country, as shown by the report were $5,658,914,153, the capital stock being $2,613,606,264, and the funded debt $2,390,915,401, leaving nearly $500,000 to be represented by unfunded debt. The average cost of all the roads was nearly $47,000 per mile, and to equip them required $418,000,000. It will be seen that the funded debt of the railroads is nearly twice as large as the interest bearing debt of the United States. The total annual income was $661,000,000, and the expense $527,000,000, leaving a net income of $134,000,000. Of this amount $70,000,000 were returned to stockholders in the shape of dividends. Not less than 300,000 persons were stockholders of the securities of the companies. The annual freight tonnage was 260,000,000 66.21 per cent. of which was carried by the middle states group, comprising lines between New York and Chicago. Nearly 90,000,000 tons of this freight was coal, and 42,000,000 tons grain. The railroads received an average of 1.29 cents per ton per mile for freight, and 2.51 cents per mile for each passenger carried.

PITTSBURG, PA., March 5.—A statement from Pittsburg and the Western officers was published to-day, to the effect that while the contemplated construction of the American Midland Railroad, following the Allegheny Valley Road along its low grade division, had been abandoned, a line would be constructed over this survey and across the Allegheny River at Red Bank, and connecting with the Pittsburg and Western at New-Castle, giving this road an outlet to Rochester, over the Pittsburg and Rochester lines from Falls City. Allegheny Valley officers say the story was started to boom the stock of the Pittsburg and Western. The same officers also said that while a survey had been made last Fall between Falls City and Red Bank, along the low grade division of the Allegheny Valley, by persons who, it was then understood, were working in the interest of the American Midland Road, nothing further had been done, and no movements of any character are taking place along the survey. The Rochester and Pittsburg people say they have a lease of the Alleghany Valley lines between these points, which does not expire for several years; hence there is no foundation for the story.

THE City Engineer of Kansas City is making plans and estimates for the new levee proposed at that place, cost to be about $10,000.

THE Kansas City Cable road is well under way, 100 tons of rails have been delivered; the weather alone preventing active work.

CONCORD, N. H., Feb. 28.—At a meeting of the Trustees of Dartmouth College here to-day, it was voted to erect a library building in connection with the institution, at a cost of $50,000. Funds for the immediate construction of a chapel at Hanover, were obtained to-day from the Hon. E. Ashton Rollins, of Philadelphia.

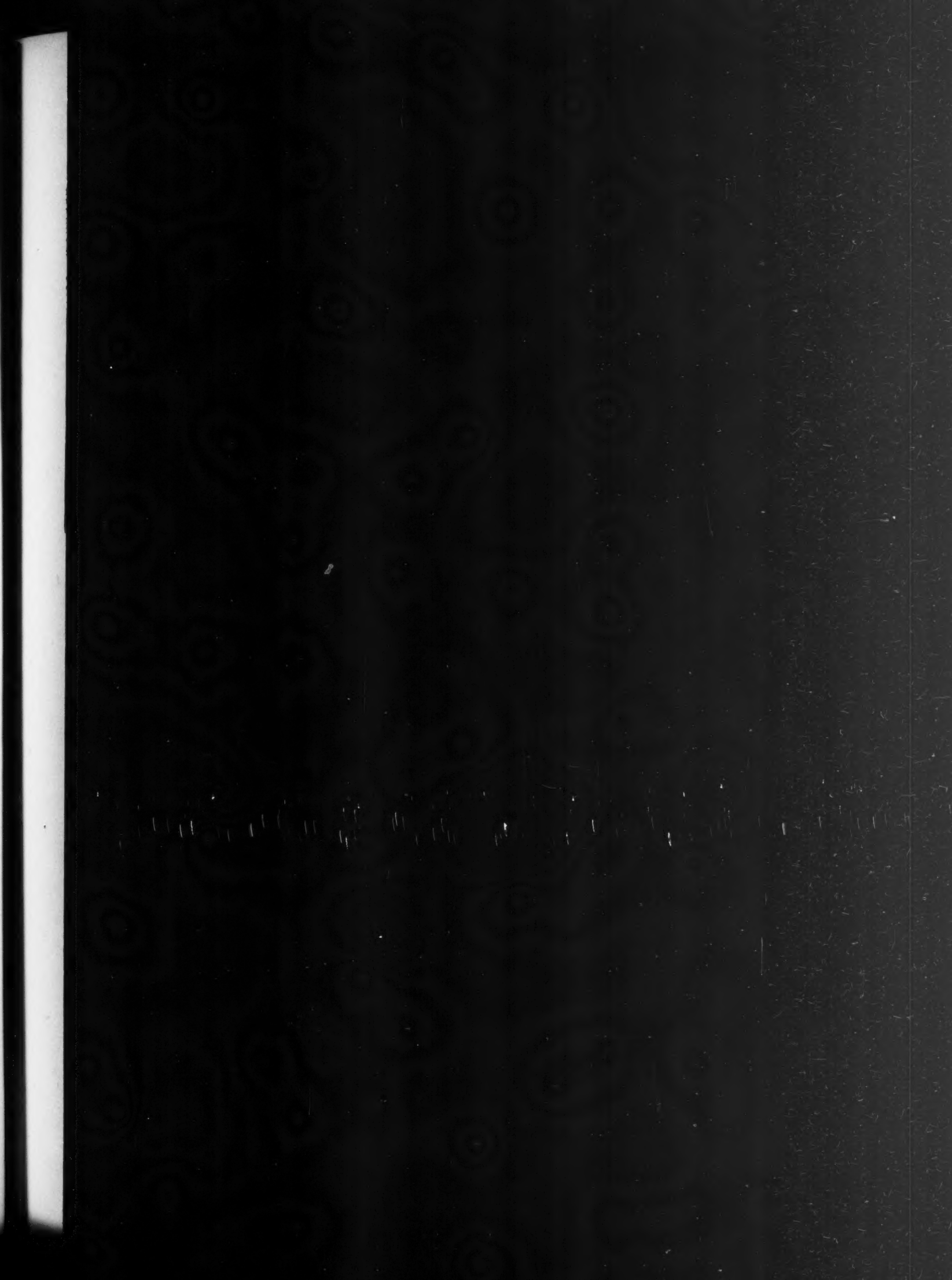
IRON, METAL AND COAL MARKETS.

PHILADELPHIA, Mar. 5, 1884.

Taking one week with another, about the same amount of business is done in Iron and Steel. There is no particular movement and no unusual inquiry, buyers and sellers seeming disposed to let the market take care of itself. Buyers are confident that when they want iron, they will be able to get it at a fair price, although production is kept at very low limits. Makers see that nothing is to be gained by crowding stock on the market or blowing in more furnaces, and are therefore quietly waiting for the tone of the market to improve. Gray Forge Iron averages $18, No. 2, $19, and No. 1 Foundry $20.50. Only small lots are moving, excepting now and then a large order is heard of; but these are generally placed at private concessions. The mills in the city are turning out about their usual amount of Iron, and selling in small lots at about 1.90 at mill, and 2c.@2.10 at store. Country mills are somewhat better supplied with orders, although it is currently believed that they have been taken at less than city prices. The situation of the Nail trade is unchanged. The usual amount is being turned out and only jobbing lots are selling. Purchasers are waiting until after April 1, before purchasing largely. In Plate, Tank, and Structural Iron no change in demand or prices can be reported, but a great deal of bridge work will be wanted, and inquiries for spring and summer delivery are in hand for Pennsylvania Railway purposes. Steel Rails are dull at $36.

PITTSBURGH, Mar. 5, 1884.

No change has taken place since last week. A great deal of railway building is projected in the middle and western part of the State. The P. R. R. has a strong corps of engineers surveying for a line of road which will afford a cut-off from Landisville to a point north of Marietta, to allow freight trains to run between Philadelphia and Harrisburg, in a single section. It will take two years to finish the road. The Converse Company, of Chicago have forced the price of Pig Lead up to 4½c. although some parties deny the statement. The movement of Crude Iron is very light. Finished Irons are rather more active; nearly all the mills are in operation; jobbers are buying more freely. Prices are weak at at 1.70@1.90c. A few orders for nails are coming in, but the outlook is encouraging. Prices are nominally $2.00. Steel Rails are firm at $35; Old Rails in active demand at $23@$24.

CHICAGO, Mar. 4, 1884.

Manufactured Iron is moving freely in small lots at $1.90 for common to $2.00 for refined. Structural Iron is in better request at 2.50c. for Tank, 2.60 for Angles, 3.50 for Channels. Galvanized Iron is moving at old prices and mills are crowded with orders. Foreign Irons are in little demand but consumers are only stocking up as usual. Pig Tin is unsettled: Sheet Copper in fair demand at 20. for bottoms; Ingot Copper, 14¾c., with concessions obtainable on large lots. Pig Iron is firm for Lake Superior; Southern Irons are in less active demand. Pig Lead 3.75@3.80. Rumors of speculative movements are afloat. Steel Rails, $36@$37 at mill, and higher prices are being asked. Mills are supplied with orders for four months, and some few run late. Demand for Merchant Steel continues light.